THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 48. Thursday, June 15, 1933. No. 878.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial: 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, the Advertisement Manager, or the Publisher of
THE FOUNDRY TRADE JOURNAL,
49, WELLINGTON STREET, LONDON, W.C.2.
Telegraphic Address: "Zacatecas, Rand, London."
Telephone: Temple Bar 3951 (5 lines).

Contents.

	PAGE
Forthcoming Events	409
Town's Gas for Furnace Use	409
Failures.—II.	409
New Nickel-Chromium Alloy	410
Book Review	410
Seaman Gold Medal Awarded to Dr. Guilliam H. Clamer	410
Temperature Distribution in Reheating Furnaces	410
Sir Robert Hadfield on the Steel Castings Report	411
Successful Finishing of Die Castings	412
Effect of Sulphur and Phosphorus on the Corrosion of Iron	413
Better Copper Outlook	415
Pig-Iron with Higher Manganese Content	416
Colbond in the Foundry	417
Mechanical Testing of Steels at Low Temperatures	418
This Week's News in Brief	419
Trade Talk	419
New Companies	419
Company Reports	419
Contracts Open	419
Personal	419
Obituary	419
Raw Material Markets	420

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN, THE NATIONAL IRONFOUNDING EMPLOYERS' FEDERATION, THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

Institute of British Foundrymen.

PRESIDENT: 1932-33:
Victor Stobie, M.I.E.E., Langholm, South Drive, Harrogate.

LIST OF SECRETARIES—
General Secretary: T. Makemson, Saint John Street Chambers, Deansgate, Manchester. London Office: 49, Wellington Street, London, W.C.2.
Birmingham, Coventry and West Midlands: L. W. Bolton, 21-23, St. Paul's Square, Birmingham.
Sheffield: T. R. Walker, 33, Ladysmith Avenue, Nether Edge, Sheffield.
Scottish: J. Bell, 60, St. Enoch Square, Glasgow.
Lancashire: J. E. Cooke, 1, Derbyshire Crescent, Stretford, Manchester.
London: H. W. Lockwood, Stewarts & Lloyds, Limited, Winchester House, Old Broad Street, London, E.C.2.
Newcastle-upon-Tyne: J. W. Eckford, 4, Mosley Street, Newcastle-upon-Tyne.
East Midlands: H. Bunting, 82, Otter Street, Derby.
West Riding of Yorkshire: S. W. Wise, 110, Pullan Avenue, Eccleshill, Bradford.
Wales and Monmouth: J. J. McClelland, 12, Clifton Place, Stow Hill, Newport, Mon.
Middlesbrough: F. A. Harper, Station Chambers, Middlesbrough

National Ironfounding Employers' Federation.
President: J. Smith, Smith & Company (South Shields), Limited, Mile Street, South Shields.
Secretary: J. A. Hassal, 106, India Buildings, Liverpool.

Foundry Trades' Equipment and Supplies Association.
President: R. H. Brackenbury, 13, Victoria Street, London, S.W.1.
Secretary: K. W. Bridges, Grand Buildings, Trafalgar Square, London, W.C.2.

Welsh Engineers' and Founders' Association.
President: W. E. Clements, Morfa Foundry, New Dock, Llanelly.
Secretary: E. J. Griffiths, 2, Royal Metal Exchange, Swansea.

BRITISH CAST IRON RESEARCH ASSOCIATION
The Registered Office and Laboratories of the B.C.I.R.A. at:—
21-23, ST. PAUL'S SQUARE, BIRMINGHAM.
Telephone: Central 1885. Telegrams: CIRA.
The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk (*Telephone 332*).

Forthcoming Events.

Institute of British Foundrymen.
JUNE 20-23.
Institute of British Foundrymen:—Annual conference in Cardiff.

Town's Gas for Furnace Use.

In spite of the great increase in the industrial use of rich town's gas for smaller furnace work in the metal and various other industries, the inherent objection to very large-scale utilisation of such gas is the high price per heat unit supplied. Now, however, the Nuneaton Gas Company, well known for pioneer work in the field of cheap low-grade town's gas, are offering their standard 200-B.T.U. gas in continuous bulk supply, when taken in large and regular quantities, at only 1.25d. per therm (100,000 B.T.U.). This means that gas supplied from the mains becomes a commercial proposition for all kinds of furnace work in metal working, as well as steam boilers, in competition with coal and coke, as well as producer gas plant operated on the premises.

Thus, for example, coal of 12,000 B.T.U. per lb. at 20s. per ton corresponds to a price of 0.89d. per therm (100,000 B.T.U.), and gas at 1.25d. per therm has obvious possibilities in many directions.

Nuneaton is the only town in the world that is running on cheap low-grade gas of only 200 B.T.U. per cub. ft., not much more than producer gas, and is also the only town operating on the scientific principle of combined low-temperature carbonisation and partial gasification of coal. As a result the cost of making the gas is only about 2d. per therm into the holder, under the conditions existing at Nuneaton, which is a small town of 50,000 inhabitants taking 200,000,000 cub. ft. of gas per annum, whilst in addition 20 galls. of high-grade crude oil, per ton of coal, are produced, along with about 9 cwts. of smokeless fuel. As against this, ordinary rich town's gas of 400-600 B.T.U. per cub. ft. costs an average of 5d. per therm into the holder, and is sold to the domestic consumer at about 9d. per therm, and it would be difficult to reduce the price in most localities to less than 4d. per therm for industry. The Nuneaton Gas Company are now offering to supply gas for industrial use at 1.25d. per therm, because with increased production their costs of manufacture would be down to about 1.0d. per therm.

This work also has proved conclusively, as the result of experience dating back to 1926, that cheap low-grade gas of 200 B.T.U. per cub. ft., supplied at a slightly higher pressure of about 8-in. W.G. at the works, gives results equal, or even superior, to rich gas of 400-600 B.T.U. per cub. ft. at 3- to 4-in. W.G., according to standard gasworks practice. All that is required for the use of low-grade gas is a minor adjustment of the existing burners, while a small booster is installed at the gasworks to raise the pressure slightly. The booster at Nuneaton takes less than 5 h.p. for the whole area, all the existing mains, valves and fittings being used as before, while it should be emphasised that the flame temperature of 200 B.T.U. gas is substantially the same as rich gas of 600 B.T.U.

Further, the capital cost of combined low-temperature carbonisation and partial gasification plants, such as used at Nuneaton, is extremely small, being only about £2,000 for a plant producing 1,500-2,000 therms for 200 B.T.U. gas per 24 hrs., which is very much less than the complicated high-temperature carbonisation plant necessary to make rich town's gas of 400-600 B.T.U. whether using horizontal or vertical retorts.

Failures.—II.

Continuing our comments on Mr. Schuster's recent Paper to the Institution of Mechanical Engineers on mechanical breakdowns and failures, the author is apparently of the opinion that breakdowns from mechanical causes outnumber breakdowns from purely metallurgical causes in the proportion of something like nine to one. Under these circumstances it seems likely that metallurgists are often called upon to find a metallurgical cause for a failure when that failure arises from a totally different cause, and, as an engineering contemporary suggests, bad design, bad workmanship, and bad handling are contributory causes rather than inherent defects in the material itself. This is only another way of saying that the metallurgist or inspector controlling the daily routine of works production probably makes a better job of his work than the designer, the worker, or the user, who all contribute their respective quotas to the completed article, or to the subsequent defect.

So far as cast iron is concerned, it is obvious to us that the whole question of the design of cast-iron parts requires to be put on a new basis as far as engineering plant is concerned, partly because newer and stronger irons are becoming available, and partly because we are gradually learning more about the strength of heavy sections and the way they behave under stress. It is a comparatively easy matter to disregard the ordinary conventions of designing theory in producing, say, a small cylinder liner, because this can be comparatively easily made and tried under service conditions, if necessary in hundreds, and the conclusions readily reached. In the case of some engineering parts, however—particularly with the heavier pieces—the opportunity to make them does not arise more than a few times per annum, and then under such circumstances that it is virtually impossible to experiment with failure. These are the conditions under which we need all the help that metallurgy and engineering design can provide for those whose task it is to settle the sections concerned, so that they may proceed with confidence, however cautious their progress may be.

New Nickel-Chromium Alloy.

The name Inconel has been given to a nickel-base chromium alloy developed by the International Nickel Company, Inc., for the dairy industry. Inconel is an alloy produced by adding to nickel sufficient chromium to give it stainlessness, without at the same time having any harmful effects on the malleability or workability of the material. The chromium content is from 12 to 14 per cent. The iron content is about 6 per cent. Inconel was first introduced a little more than a year ago, and since that time has been extensively used.

Advantages claimed for Inconel are: (1) Highly resistant to corrosion in contact with refrigerating brines, ammonia and cleaning and sterilising compounds; (2) non-rusting; (3) non-tarnishing—attractive in appearance; (4) non-contaminating; (5) excellent welding and fabricating properties; (6) equipment has satisfactory heat-transfer projection; (7) easily and thoroughly cleaned. The three principal features of the corrosion resistance of Inconel are stainlessness, resistance to pitting penetration by brines and its amenability to welding without danger of subsequent weld decay.

Inconel is hardened by cold working at about the same rate as pure nickel and, therefore, its fabricating qualities are about the same. The metal can be drawn into shapes without difficulty. It lends itself well to lock seaming and soft soldering, and the bond between the solder and the metal is excellent. It can be brazed or silver soldered. Welding is being accomplished by both oxy-acetylene and arc-welding methods. It is stated that welded joints in Inconel are not subject to inter-granular deterioration nor do they require heat-treatment to bring out best corrosion resistance. Metallic-arc welding is said to be highly practical with all heavy gauges and even as light as 18 gauge. The ductility of the metal permits the ready fabrication of tubes into coils.

Inconel seamless tubing with inside sanitary finish, states "The Iron Age," is available in sizes 1 in. and larger. Special lipped tubing is also available for cooler construction. Pure nickel sanitary tubing is also available in all sizes 1 in. and larger.

Book Review.

Belting and Its Application, by J. DAWSON, JUN., M.C. Published by Chapman & Hall, Limited, 11, Henrietta Street, London, W.C.2. Price 10s. 6d. net.

Actually, the transmission of power should be as much a finished science as pattern making, but lamentable ignorance is constantly encountered in the various works. We see standard plant being actuated by motors varying from 2 to 10 h.p., and much the same variation applies to the belting used. The book is divided into fifteen chapters, but of all we consider that Chapter XIV is most interesting, as it is devoted to power transmission by V-ropes. This development is insufficiently known and appreciated by many foundrymen. The jointing of V-belt ropes, which consists of a number of built-up sections, is particularly interesting and very intelligently set out.

The book is both a text-book and work of reference, and though the author happens to be associated with one of the most important firms of belting manufacturers, in the capacity of technical director, the book is entirely free from either advertising matter or bias. There is, to our mind, one omission, and that is the absence of some matter dealing with belts as conveyor units. The book contains just the type of knowledge a foundry manager wishes that he possessed some time during his career, especially if his foundry has been, or is being, mechanised. The book, which is profusely illustrated with 167 pictures and diagrams, is really excellent value for its very moderate cost.

V. C. F.

Seaman Gold Medal Awarded to Dr. Guilliam H. Clamer.

It is announced by the Board of Directors of the American Foundrymen's Association, acting on recommendation of the Board of Awards, that the Joseph S. Seaman Gold Medal of the Association has been awarded to Dr. Guilliam H. Clamer for outstanding achievements in the metal-casting industry. Presentation of the medal will be made during the 1933 Annual Convention in Chicago, at the annual business meeting on June 22. Mr. Clamer has been associated with the advancement of metal casting, particularly non-ferrous metals, for nearly 40 years. Under his executive direction many valuable improvements in melting and casting practice have been developed. Constantly active in the activities of technical societies allied with the foundry industry, he is a past-President of the American Foundrymen's Association and a life member of the Advisory Board.

On graduating from the university in 1897 with a B.S. degree in chemistry, Mr. Clamer established a chemical laboratory at the Ajax

DR. G. H. CLAMER
(This year's Seaman Gold Medallist).

Metal Company, Philadelphia, with whom he has been associated ever since. This was one of the first, if not the first, time a chemist had been regularly employed in the American non-ferrous foundry industry. On taking up this virgin field he became engaged in analysing competitors' alloys (then secret), developing the scientific use of scrap based on analysis, checking purchases of materials, and working out a system of manufacturing control and product-checking. Later he was instrumental in developing numerous high-load, high-strength and special alloys for many types of service requirements, as well as ferrous alloys and copper-nickel steels, the latter used during the war in the manufacture of shells, gun-carriage castings, etc., In improving upon methods of employing scrap metals, Mr. Clamer's experiments led to invention of a refining process in 1901 for which he received the Elliot Cresson Gold Medal of the Franklin Institute. Still later, under his executive direction, his company developed several improved types of furnace for non-ferrous metal-melting, especially electric induction furnaces.

Mr. Clamer was the first non-ferrous member of the American Society for Testing Materials and is a Past-President. He was influential in setting up their first non-ferrous committee and has prepared numerous Papers on alloys, metallurgy and melting equipment for various technical groups and trade papers. As further evidence of his participation in association work, he is a Past-President of the American Institute of Metals and the Mining and Metallurgical Section of the Franklin Institute; member of the board of managers, Franklin Institute, for 20 years, and chairman of the Committee on Science and the Arts; charter member of the American Electrochemical Society; member of the American Institute Mining and Metallurgical Engineers, American Society for Steel Treating, American Institute of Electrical Engineers; member of the Non-ferrous Technical Advisory Committee of Bureau of Standards for nearly 20 years; member of the Iron and Steel Institute, a member of the Institute of Metals and the Institute of British Foundrymen.

Mr. Clamer was the A.F.A. member appointed to represent the non-ferrous foundry industry in contacting on technical matters with the U.S. Government in the war. He also was vice-president of the war-service association of manufacturers of solder and babbitt metal. To-day, besides his connection with the Ajax Metal Company, he is president and general manager of the following: Ajax Electric Furnace Corporation, Ajax Electrothermic Corporation, and Ajax Electric Company, Inc.

Mr. Clamer received the Honorary Degree of Doctor of Science from the Ursinus College, Collegeville, Pa., on June 5, because of his position and achievements in the scientific field.

Temperature Distribution in Reheating Furnaces.

In Report No. 174 of the Heat Economy Bureau of the Association of German Ironmasters, published in "Archiv für das Eisenhüttenwesen," H. STOFFREGEN describes measurements of the heat distribution in reheating furnaces. Measurements were made with a hollow copper sphere containing a thermocouple in reheating furnaces at the Peiner rolling mills.

A marked temperature gradient is found through the furnace, which over short intervals may be regarded as a black-body radiator. This condition is maintained on passing a current of gas through the furnace at a temperature higher than that of the furnace walls. But if a body is heated by the gas stream to a temperature much higher than the walls or the ingots, its emissivity must be taken into consideration.

The total heat absorbed by the copper sphere was measured and it was found that the heat flow is greatest in the middle of the furnace above the ingots and decreases from this point in both horizontal and vertical directions. These differences are not found at the front of the furnace where the turbulence of the gases makes the thermal conditions independent of position. The greatest differences in heat-transfer conditions were found in a section 11.75 metres from the furnace door, and were 22,700 kcals. per sq. in. per hr., *i.e.*, 24 per cent. of the lowest value.

Temperature measurements at the interior of the ingots were made by fixing metals of known melting points at the points of measurements, the fusion of which was shown by a ceramic indicator. The temperature differences at the ingots are due to the water-cooled rollers and the temperature gradient, particularly at the entrance to the furnace. The differences due to the latter cause can be considerably reduced by suitably arranging the side burners and controlling the furnace temperature and the heating conditions. The maximum temperature difference was 300 deg. at a point 13 m. from the furnace door, *i.e.*, 37 per cent. of the lowest ingot temperature. On leaving the furnace, the difference in temperature at the ingot was only 80 deg., although in this experiment a very satisfactory temperature distribution was obtained.

Sir Robert Hadfield on the Steel Castings Report.

After the presentation of the Report to the Iron and Steel Institute, Sir Robert Hadfield made an important contribution to the discussion. This he has since amplified somewhat, and he has been kind enough to provide us with the photographs which illustrate his remarks.

In view of the widespread publicity given to the Report, we reproduce Sir Robert's contribution *in extenso*. He said:—

I have read with great interest the First Report of the Steel Castings Research Committee, and should like to congratulate the chairman, Dr. H. Moore, and his colleagues on the care and trouble they have bestowed in dealing with this subject.

Hydraulic Cylinders.

I have in my time been concerned in the manufacture of very complex steel castings, and I mention the following instances because they seem to bear on the propositions submitted

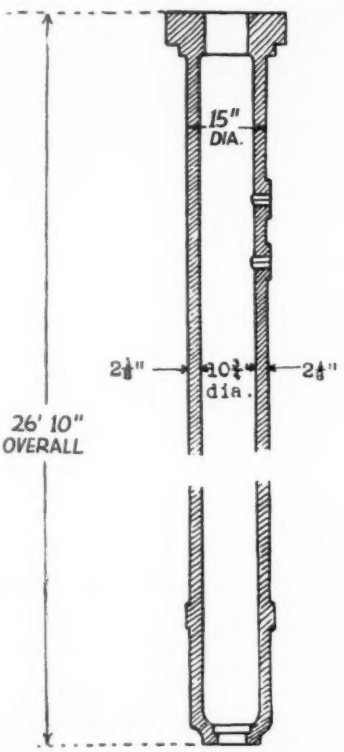

FIG. 1.—THIS HYDRAULIC CYLINDER HAD WITH ITS "HEAD" A LENGTH OF ABOUT 30 FT. IT MUST POSSESS NO POROSITY OR UNSOUNDNESS THROUGHOUT ITS 10,400 SQ. IN. INTERNAL AREA.

by the Report, also to show that British steelfounders are quite capable of meeting all the requirements of the home market. I would not like the daily or the technical Press to imagine from this Report, which of course in any case does not intend to convey such a meaning, that this country cannot obtain within itself its requirements whether as regards light or heavy steel castings. This is further proved by the fact that the last import returns show that the value of such import work has dwindled to only about £2,000 per month, whereas formerly this figure was ten times or more as much. It is, of course, quite easy to pick out certain very difficult articles, for example, thin in section, of comparatively light weight and of straggling nature, in which all the difficulties are experienced, unsoundness, pulling and so on, but I venture to say that, given a sufficient number of castings as the order, such articles can be produced and without much difficulty, proper attention being given to the design of the pattern, the avoidance of sharp corners, the use of brackets to overcome contraction difficulties and so on.

Let me state briefly my own experience and that of my company, Messrs. Hadfields, Limited, of Sheffield.

One of my company's productions has been in the form of hydraulic cylinders (Figs. 1 and 2) of which they have produced many thousands for cotton presses which, including the head feeding, represents a total length of some 32 ft. with walls only 1¾ in. to 2¾ in. in thickness. To give some idea of the difficulties which have to be overcome, the sensitive molten steel at a temperature of about 1,530 deg. C. has to drop from the top no less than 32 ft., and yet these thin walls must be perfectly sound, as they have to withstand hydraulic test pressures up to 3½ and sometimes 4 tons per sq. in. and a constant working pressure about 2½ tons per sq. in. The contraction in this long mould is over 8 in., that is, to obtain the desired length of the casting, say 32 ft., the mould has to be 32 ft. 8 in. in length. To obtain success it is necessary that the steel should be known to be absolutely free from suspicion as to unsoundness, also immediately after casting and the steel has "set" that the clamped moulding box should be removed in order to allow the large amount of contraction to which I have referred to take place without rupture.

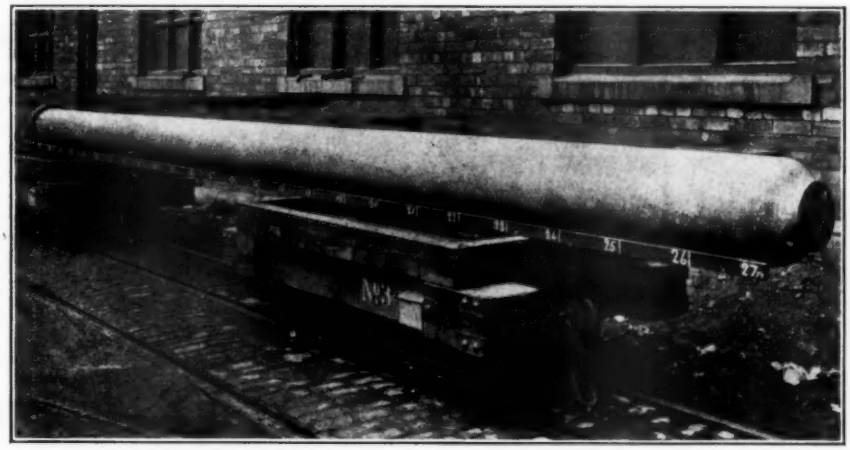

FIG. 2.—THE HYDRAULIC CYLINDER CASTING SHOWN DIAGRAMMATICALLY IN FIG. 1.

Steam Valve Box Castings.

Other castings which I well remember causing no little difficulty in our works at the time we had to make such articles many years ago for the Admiralty were certain steam-valve box castings each weighing about 26 cwts. The accompanying photographs show, Fig. 3, the casting and the outlines of its thickness; Fig. 4 a similar casting which in order to show the toughness of the steel was attacked at our proof butt with a 10½-c.m. armour-piercing shell; the shell naturally perforated the thin walls on both sides; the casting did not, however, in any way split or break, showing its excellent toughness. A similar casting submitted to the Admiralty successfully stood steam pressure and was accepted into the Service. These castings, if I remember rightly, contained about 0.40 per cent. carbon and 1.50 per cent. manganese.

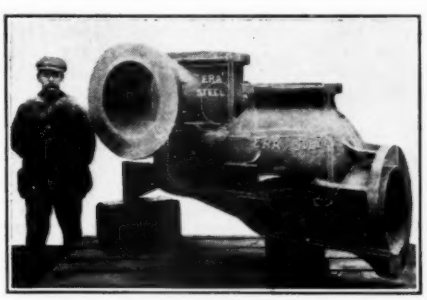

FIG. 3.—STEAM VALVE BOX CASTING, SHOWING INTERNAL CONSTRUCTION.

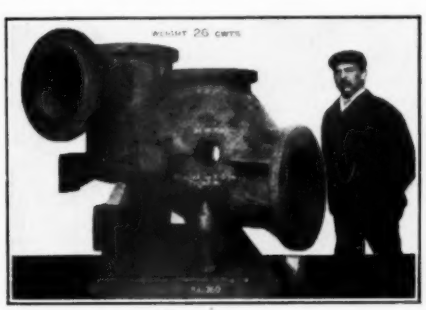

FIG. 4.—THE VALVE CASTING, SHOWING NO CRACKS AFTER PIERCING WITH A 4½-IN. A.P. SHELL.

Shields.

Another instance of a successful steel casting of somewhat different nature is shown in the accompanying photograph, Fig. 5. This cast shield was attacked by three 4.7-in. armour-piercing shell, one 6-in. common shell and one 6-in. capped armour-piercing shot, representing a total striking energy of 8,950 ft. tons on an area of impact of only 13 sq. ft. It can be well understood that the casting required to be a perfect one free from blow-holes or cracks, also very carefully annealed.

In a majority of cases, if I may submit a few words for consideration, if the following points are attended to, many of the troubles met with in the production of ordinary steel castings can be avoided.

The article should be designed to suit the contraction of the fluid steel, bearing in mind its temperature of some 1,500 deg. C. Sharp corners should be avoided, and much more bracketing of thin and thick parts together should be employed. This is sometimes avoided because of the trouble involved in chipping

them off. It is, however, a question of more haste less speed, as without brackets pulling will occur. Sudden changes from thin to thick sections should be avoided. Thus, the engineer should most certainly consult the steel founder when making up his design.

As to the nature of the steel to be employed, this is exceedingly important. It should first be known that the type of fluid steel which is being used is sound before it is poured. There are plenty of simple devices for testing this. My own feeling is that heats of steel are often employed which possess the disease of unsoundness to start with; therefore, castings made from such material are much more liable to unsoundness, pulls, cracks and other defects.

There is often insufficient contact between the moulder, who knows nothing about the steel, and the metallurgist, who knows all about it but does not know about the moulding side.

In this respect I should like to call attention to a plan we have in mind at the Sheffield University, one which has been presented by our new chief in the Metallurgical Department there, Prof. J. H. Andrew; Mr. V. C. Faulkner has also given the plan his blessing. I refer to better education for the foundryman himself down to the actual moulder. The poor moulder often gets kicks for supposed carelessness when it is not his fault. Moreover, in this complex work of preparing the mould, all kinds of strange materials are met with as compared with the much more easily-handled sand and composition used for cast iron and non-ferrous products. Of this the average foundryman knows but little. This idea of a degree course for foundry executives such as Prof. Andrew has outlined has my heartiest support, namely, that the steel foundryman himself should also be further taught in the same way as chartered engineers.

The present moulder is born and not made, and very good fellows most of them are, but they are lacking in knowledge, which is not their fault, because they have never had the means of training properly presented to them or made available.

The Indian Railway Standing Committee has decided to expend Rs. 201 lakhs in the year 1934-35 on the rolling-stock programme of various railway administrations. The amount is distributed as follows:—Locomotives, Rs. 49 lakhs; boilers, Rs. 43 lakhs; carriages, Rs. 91 lakhs; wagons, Rs. 18 lakhs (1 lakh = £7,500). This does not include the purchase of broad-gauge general-service wagons, which will be considered later.

Successful Finishing of Die Castings.*

By Edgar Parkinson and Frank V. Faulhaber.

Alloys of comparatively low fusing points are used as a rule in the production of die castings. For that reason additional difficulties sometimes crop up when baking methods are used for finishing. The alloys entering into die cast work can be classified into four categories. There are the tin-base alloys, composed of 60 to 80 per cent. of tin, 2 to 7 per cent. of copper, 3 to 7 per cent. of antimony, and sometimes a small percentage of lead. Then there are lead-base alloys, consisting of 80 to 96 per cent. of lead, 4 to 20 per cent. of antimony, and sometimes as high as 10 per cent. of tin.

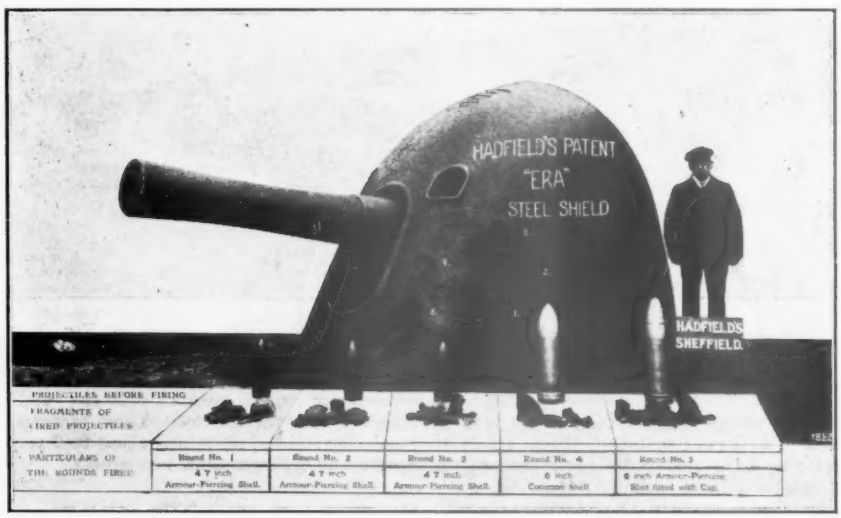

Fig. 5.—This Gun Shield has received Five Rounds of Shell Fire, but though its Area is but 13 sq. ft., adequate Protection has been given to both Crew and Gun.

Next there are zinc-base alloys, composed of approximately 80 to 95 per cent. of zinc and small amounts of tin and copper, or aluminium and copper. Finally, there are aluminium base alloys, containing about 90 per cent. of aluminium, mixed with small percentages of copper, nickel and silicon.

In the foregoing four groups of alloys it will be noted that all contain large proportions of metals which are themselves hard to finish. Trouble is often encountered, for example, in making a finish adhere successfully to zinc, lead or aluminium. This is due not only to the extremely smooth surface of these metals, affording no "grip" for the finish, but also to the inherent "greasy" quality of these metals.

Eliminating Entrained Gases.

In addition to this, in the manufacture of die castings, small quantities of air or other gases are often entrapped in the metal. Later, if the die-castings are baked, this air or gas is often driven out of the metal, which causes the formation of small pimples or blisters, on the surface of the finishing material.

It cannot be too strongly emphasised that the finishing department should at all times see to it that the work is perfectly clean. All traces of grease, grime, oil and so forth, should be removed. The product should be handled no more than is necessary. Too often finger-prints are left upon the completed product. At times rejected work means lost future business.

Whether either baking or air-drying materials enter into the finish of the die castings, the ready-for-finishing work should show a clean surface. The cleaning can be accomplished by means of sand-blasting. This method not only removes the grease and oil, but also leaves or affords a slightly roughened surface, to which the finishing material will adhere much better than to a smooth, even surface.

In some plants the cleaning of castings is not performed as carefully and thoroughly as it should be. The castings are washed with naphtha and then dried with cloths. However, when this method is employed care must be exercised frequently to change the naphtha to prevent the concentration of oil or grease becoming sufficient to deposit a thin film on the work. Also, the wiping cloths should be discarded as soon as they begin to show any traces of oil or grease. Attention to these details will lessen the finishing difficulties that otherwise later might be encountered.

Caustic Solution for Cleaning Die Castings.

A weak caustic solution can be employed to advantage, if proper care is exercised, when cleaning the die castings. The caustic will not only dissolve the grease and oil, but will also attack the metal slightly and produce an etched surface to which the finishing material will adhere. Precaution must be taken, however, that the castings be not left in the caustic bath longer than a few seconds, as the caustic will quickly dissolve aluminium, zinc and some of the other metals.

When withdrawn from the bath the castings should show a bright appearance. If a tarnished surface is shown, it indicates that the parts have been immersed too long, which will often cause pitting of the metal. The solution used should be maintained at a temperature of approximately 160 deg. Fah. to avoid any possibility of penetration into the pores of the metal. Due care in this will forestall perplexing and costly finishing troubles that many plants encounter.

Once the die castings are thoroughly cleaned, the finishing department is in position to produce quality finishing. There is no other preliminary work entailed when air drying finish is employed. Many experienced finishers have found that the duller-drying finishing materials, incorporating considerable pigment, ensure better results than glossy ones.

Pre-Baking Details.

When baking of the parts is employed a special precaution must be taken, following the cleaning operation and preparatory to the application of the finish. Because of the air and other gases caught in the pores of the metal, it is desirable to first heat the castings to a temperature at least 15 or 25 deg. higher than that at which the finishing material is to be baked, holding this temperature for a period of 30 min. to one hour. This preheating removes any grease or oil remaining on the cast parts after cleaning, and also causes any gas or air entrained in the metal to break through the surface.

When pimples or pin heads can be found on the surface of the castings as a result of this treatment, these can be easily removed by sanding. When this preparatory procedure is disregarded, finishing difficulties are likely to ensue. When baking on the finishing material, there will be an expansion of the entrained air or gas, causing small pimples or pin heads on the surface. However, if the castings are given the first coat as soon as they are cool enough after this preliminary heating, and then baked at a temperature slightly lower than that at which the bare casting was heated, there will be little difficulty experienced.

Each casting presents an individual problem. Different die castings will withstand different baking conditions, depending upon the composition of the alloy undercoat. Die castings formed on a base of tin, lead or zinc, should usually not be heated higher than 250 deg. Fah.; otherwise the metal, which has a low melting point, may sweat out of the casting and cause trouble. Die castings which contain no tin can be baked at

(*Concluded on page* 418.)

* Extracted from the "Iron Age."

Effect of Sulphur and Phosphorus on the Corrosion of Iron.*

By L. Tronstad and J. Sejersted.

(Slightly Abridged.)

Introduction.

It is often found that localised corrosion of metals is connected with discontinuities which constitute weak places of the natural oxide film. Any endeavour to avoid this dangerous type of attack calls for knowledge regarding those inclusions at which localised attack is most liable to commence. Palmær has shown that when

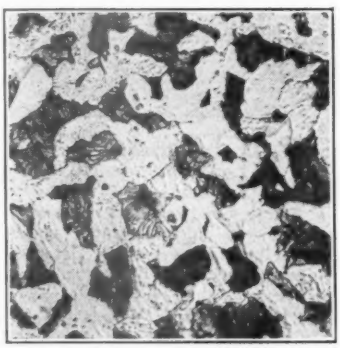

FIG. 1.—MICROSTRUCTURE OF SAMPLES NOS. 1 AND 4 (SAME MATERIAL). × 300.

iron containing graphite flakes is immersed in acids, vigorous attack occurs around these inclusions; he has also established a relation between the total solution of the iron and the graphite content. In general, however, the inclusions which stimulate localised attack have received less attention than they deserve.

The inclusions are generally of microscopic size, and can best be detected during the corrosion process by means of a water-immersion objective; their composition may be determined by micro-analysis. Chemical reactions carried out in viscous films under the microscope may also be of service.

The object of this investigation was to examine the effects of the sulphur and phosphorus contents on the corrosion of iron. In addition to

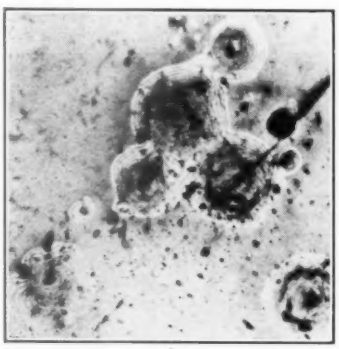

FIG. 2.—LOCALISED ATTACK AFTER 1 HR. GREEN LIGHT FILTER. × 500.

the study of localised corrosion, the programme included determinations of the weight loss and oxygen absorption as measured by the reduction of a chromate solution.

For the determination of the weight loss and oxygen absorption, two series of ferrous materials were used:—(1) One with an almost constant content of carbon, silicon, manganese and sulphur, but an increasing phosphorus content; (2) the other with an almost constant content of carbon, silicon, manganese and phosphorus, but an increasing sulphur content. The compositions are shown in Table I. All materials received the same heat-treatment, and, owing to the uniform carbon content (0.4 per cent.), they displayed, when etched with 1 per cent. nitric

TABLE I.—*Composition of Materials Used (per cent.).*

Sample.	Carbon.	Silicon.	Manganese.	Sulphur.	Phosphorus.
Increasing phosphorus content.					
1	0.40	0.28	0.22	0.013	0.011
2	0.42	0.20	0.26	0.014	0.021
3	0.39	0.25	0.20	0.013	0.030
Increasing sulphur content.					
4*	0.40	0.28	0.22	0.013	0.011
5	0.41	0.32	0.26	0.027	0.013
6	0.45	0.30	0.30	0.040	0.012

* Same as No. 1.

acid, an almost identical pearlitic structure. The structure of samples, Nos. 1 or 4, which come from the same material, is shown in Fig. 1. On the etched samples particles of FeS and MnS were only visible in No. 6, which had the highest sulphur content, and no Fe_3P phase was detectable in any of the materials. On the unetched samples the iron and manganese sulphides were, as usual, seen mainly at the grain boundaries as ridges possessing a more or less globular character. The solid solubility of phosphorus in iron is much higher than that of sulphur, and consequently the small quantity of phosphorus will be present mainly in solid solution.

The loss of weight method was adopted to obtain information about the effect of added elements, a polished surface being used to minimise complications due to cracks; alumina was employed instead of rouge, since, as shown by one of the authors in previous work, it avoids serious surface oxidation. Iron rods (5 by 1 by 1 cm.) were drilled with holes, ground with emery paper, polished with alumina on felt pads, washed with water, dried with absolute alcohol and preserved for several hours in a desiccator. After degreasing in carbon tetrachloride, the

TABLE II.—*Weight Loss of the Six Materials in 2N NaCl (100 deg. C.).*

Sample No.	1	2	3	4	5	6
Weight loss Mg. per sq. cm. ...	0.30	0.35	0.35	0.30	0.45	0.70
	Increasing phosphorus content.			Increasing sulphur content.		

specimens were hung by glass hoods for 18 hrs. in boiling 2*N* sodium chloride, the immersed area being 22 sq. cm.; the 2-litre flask was fitted with a condenser to avoid evaporation, and a stream of oxygen was passed through the solution during corrosion so as to preserve a constant oxygen concentration. After corrosion, the specimens were freed from rust by cathodic treatment in citric acid for one minute, washed with water, dried with absolute alcohol and weighed. Table II shows the weight losses, each value representing the mean of four measurements. Clearly the sulphur has stimulated the rate of corrosion, whereas the phosphorus has produced no appreciable effect.

Determination of the "Oxygen Absorption."—As shown by Bengough and his collaborators, and afterwards by Evans and Hoar, the amount of absorbed oxygen is, in the absorption type of corrosion, directly proportional to the weight loss. This suggested the use of the oxygen absorption to obtain confirmatory evidence. For general purposes a simple apparatus is unsuitable, but in the present investigation it has been thought sufficient to determine the rate of reduction of potassium dichromate. Oxygen, like chromate, stimulates the corrosion by acting as a depolariser at the cathodic areas, and a simple relation should exist between the absorption of oxygen and the reduction of chromate. The chromate consumption of the various materials should therefore give information regarding their resistance to corrosion.

A flanged glass cylinder (4 cm. high and

FIG. 3.—THE SAME AREA AS THAT SHOWN IN FIG. 2 AFTER 15 HRS. EXPOSURE. GREEN LIGHT FILTER. × 500.

3.5 cm. in dia.) was screwed down into contact with the horizontal polished surface of the specimen, a rubber ring being used to obtain a watertight joint; the area of the metal exposed within the cylinder was 9.6 sq. cm. The combination was then placed at the bottom of a wider glass cylinder, filled with carbon dioxide, and 25 ml. of oxygen-free solution containing NaCl (2*N*) and $K_2Cr_2O_7$ (0.02*N*) were introduced. The temperature was controlled in a water thermostat at 20.0 deg. C. After 60 hrs. anærobic corrosion, the residual chromate was determined volumetrically by the iodine method. The chromate consumption, expressed as absorbed oxygen, is shown in Table III, each value being the mean of four

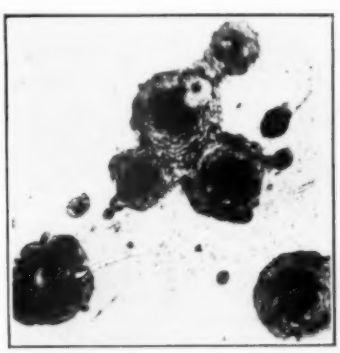

FIG. 4.—THE AREA SHOWN IN FIGS. 2 AND 3, AFTER VIGOROUS WASHING WITH RUNNING WATER TO REMOVE LOOSE RUST PARTICLES. GREEN LIGHT FILTER. × 500.

measurements. Here again the phosphorus content has exerted no appreciable influence, whilst the sulphur has produced a marked effect. The figures are in general agreement with those given in Table II; but, since the depolariser, time and

* From a Paper read before the Annual Meeting of the Iron and Steel Institute.

temperature are different in the two cases, quantitative correspondence was hardly to be expected, especially in view of the slight acidity of the solution in the second case, due to carbon dioxide. The fact that the phosphorus is present in solid solution, whilst the sulphur occurs as inclusions at grain boundaries, suggests that inclusions affect the corrosion more than substances

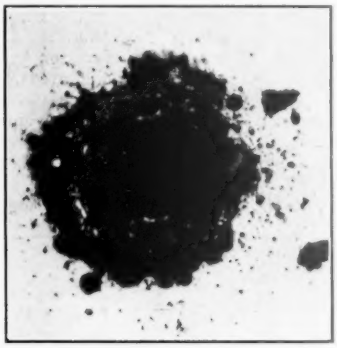

Fig. 5.—A Larger Attacked Area on the same Specimen as that shown in Figs. 2 to 4. Green Light Filter. × 500.

which merely modify the ferrite lattice (provided that these do not produce a resistant coating). It is very probable that the sulphide inclusions stimulate the attack by constituting weak points in the metal surface—a suggestion recently made by C. E. Homer.

It is known that heterogeneous materials

Table III.—*Chromate Consumption of the Six Materials, Calculated as Milligrammes of Oxygen absorbed per sq. cm.* (20 *deg. C.*).

Sample No.	1	2	3	4	5	6
Oxygen absorption. Mg. per sq. cm.	0.0117	0.0123	0.0120	0.0117	0.0165	0.0255
	Increasing phosphorus content.			Increasing sulphur content.		

usually suffer regional corrosion, whereas materials containing relatively few inclusions are more liable to localised attack. The materials referred to above contain too much carbon to show up the influence of single particles, and for this purpose an annealed material with carbon 0.08, phosphorus 0.014, sulphur 0.061

Fig. 6.—Localised Attack at an Advanced Stage. Green Light Filter. × 500.

and manganese 0.48 per cent. was used; the microstructure consisted of large ferrite grains, with pearlite islands and sulphide particles along the grain boundaries.

The specimens, ground and polished as before, were mounted as in the chromate tests, and placed under a microscope fitted with the water-immersion objective. The corroding solution contained sodium chloride (2*N*) and sufficient sodium chromate to keep the attack localised. Shortly after immersion interference rings appeared around a number of slag inclusions. Around certain particles the expansion of the rings ceased after about 30 min., but in a few cases it still continued. After 30 min. the first brown rust particles were observed round about the active centres; in many cases they were deposited as ridges, forming a rust ring around the central inclusion.

Fig. 2 represents, after corrosion for 1 hr., the state of a specimen which had been exposed to the air for a few minutes only between polishing and immersion. The diameter of the interference rings was here about 0.02 mm., but occasionally inclusions with much larger rings were observed. The number of fringes also varied within a wide range around different particles. During the extension of the rings, it was sometimes noticed that they contracted and shortly afterwards expanded again. This phenomenon may indicate the presence of the natural-oxide film, somewhat strengthened by the action of the chromate. The central inclusions are visible as black spots, but the smaller black spots within the attacked areas are mostly rust particles. Rust rings in an early stage of formation may also be observed as darker ridges. The micrograph makes it clear that a number of the slag inclusions (seen as black spots outside the interference rings) are "inactive."

Several of the attacked areas produced no appreciable rusting; this indicates that the initial attack had ceased. Generally, however, the formation of rust interfered with observation after a short time. Fig. 3 shows the same area as Fig. 2 after 15 hrs. exposure; the active areas are now completely covered with rust, rendering sharp focussing impossible. The rust heaps were visible to the naked eye as tiny brown spots scattered over the bright metal surface. The loose rust particles were removed by vigorous washing with running water, and the area was again photographed (Fig. 4). The most conspicuous difference between Figs. 2 and 4 is the lack of brilliance inside the attacked areas. Interference fringes are still present, but, generally, they now show colours of higher orders and are more broken up. At the centres the dark spots are still visible, surrounded by their dark rust rings. By raising and again lowering the microscope tube, a cavity outside the central inclusion could be detected. Fig. 5 shows a larger attacked area (dia. about 0.06 mm.) on the same specimen after washing. Here the interference fringes are still more broken up, the rust ring is more pronounced, and the cavity around the central inclusion is wider and deeper.

In general, the age of the natural-oxide film and the concentration of chromate were the main factors controlling the number of active centres and the rate of attack. Long exposure to air, or high chromate concentration, reduced the number. In addition to localised corrosion, regional attack was occasionally observed at certain ferrite grains.

In following the course of attack at the active centres, it was occasionally found necessary to raise the microscope and stir the liquid in order to clear away loose rust particles. In this manner it was possible to observe the formation and growth of the ring cavity around the active inclusions. The attack did not follow the grain boundaries, but spread concentrically around the inclusions. The slag inclusions themselves seemed to become to some extent broken down, and at the sites of the inclusions gas bubbles occasionally appeared. These two occurrences were usually more pronounced in a sodium-chloride solution free from chromate. Fig. 6 shows, on a different specimen, the local attack at a more advanced stage. The specimen was here taken out, washed with water (no rubbing), dried with alcohol and examined in the air. The central part of the attacked area is deeply etched. Newton rings are also to be seen, whilst at the edge of the cavity a rust ring seems to be present.

The liberation of gas at some of the active centres was confirmed by experiments conducted on specimens covered with viscous films. The polished specimens were coated with a film of 2*N* sodium-chloride solution containing 4 per

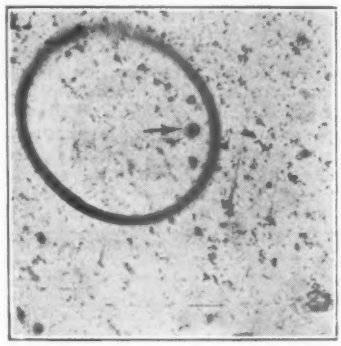

Fig. 7.—A Gas Bubble Formed at an Inclusion. × 100.

cent. of gelatine and protected by a cover-glass; no depolariser was added. Under these conditions the gas bubbles were easily detected under the microscope, but, since the corroding medium was forced away by the gas, their growth soon slackened. Fig. 7 shows a gas bubble after 6 hrs.; it is visible as a black ring, whilst the particle at which the evolution had started is marked with an arrow. As previously shown by one of the authors, the gas formed in this way does not give the lead-acetate test for hydrogen sulphide, and must, therefore, be regarded as hydrogen.

Emphasis must be laid on the fact that the localised attack is stimulated only by some of the slag inclusions present. The results of the work on weight loss and oxygen absorption suggest that the active centres consist of sulphides of iron and manganese, as was confirmed by microchemical analysis.

Microchemical Analysis.

A very sensitive reaction for the detection of sulphides is based on the fact that they catalyse the reaction:

$$2NaN_3 + I_2 = 2NaI + 3N_2.$$

In a viscous film, therefore, a gas bubble should be formed at each active sulphide inclusion. Here, gelatine is clearly unsuitable owing to its sulphur content, and a liquid composed of 100

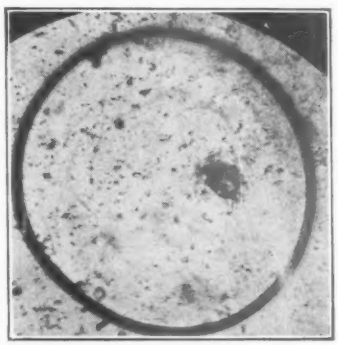

Fig. 8.—A Nitrogen Bubble at a Local Centre of Attack. × 100.

ml. of glycerin, 0.03 grm. of sodium azide, 0.0127 grm. of iodine and 0.025 grm. of potassium iodide was employed. This solution appeared to be very stable. The specimen, which had been subjected to localised attack in sodium chloride, was washed and dried with alcohol. After applying the azide-iodine solution, the surface was

covered with a carefully-cleaned cover-glass. In every experiment the evolution of nitrogen was quickly observed in the pits, indicating the presence of sulphide. Fig. 8 shows a bubble formed in this way.

The other constituents of the active slag inclusion could not be identified by the viscous film method, owing to the necessity of an acid medium. A sample of material was, therefore, removed from the centre by means of a fine needle, under the microscope, and analysed micro-chemically. The results were as follows:—(1) Sulphide was again detected by sodium nitro-prusside; (2) phosphide was not detected by benzidine and ammonium molybdate after oxidation; (3) silicon was not detected; (4) manganese was detected by benzidine; (5) iron was detected by potassium thiocyanate.

Evidently, it is the iron-manganese sulphide inclusions which are most liable to stimulate the formation of localised attack, a fact also established by Homer by means of the ferroxyl indicator.

As is well known, the electro-chemical theory of corrosion attaches essential importance to those impurities or inclusions which can stimulate local electric currents by differential aeration or otherwise. Measurements have shown that the corrosion produced at anodic areas is equivalent to the current flowing, and that this current is largely controlled by the polarisation at the cathodic areas. Assuming that a certain number of the sulphide inclusions constitute weak places in the oxide film, the problem resolves itself into finding an explanation for their specific behaviour.

As stated by Benedicks and Löfquist, chemical reactions may, under certain conditions, occur between the slag inclusion and the surrounding metal. Thus, the constitution of the metal in contact with slag inclusions may differ from that at a distance from them. Assuming the properties of the protective film to depend on the composition of the metal, it is easy to explain the local weakness. Furthermore, it is not unlikely that the natural film is broken at the boundary of certain inclusions, since there may be differences between the thermal expansions of the two substances in contact or differences in the adhesion of the film. Moreover, it is possible that the sulphides are uncoated, thus allowing the attack to commence at the boundary and spread outwards, so as to undermine the protective film.

A most important factor in the behaviour of sulphide or other inclusions may be the incidental presence of crevices. Usually, a slag inclusion is in perfect contact with the metal. But differences in thermal expansion or weak adhesion between metal and sulphide may lead to boundary cracks of capillary size, whilst the grinding and polishing process may tend to tear away the brittle sulphide inclusions from the material around them. Crevices may also be formed during rolling.

The presence of crevices may, therefore, be responsible for the active character of the sulphide inclusions. According to the "differential aeration principle," the metal in the crevices, being screened from oxygen or other depolarising agents, is anodic. Evidence in support of this idea was obtained by the local formation of rust, and the blue colour obtained with the ferroxyl indicator by Homer at active centres is also significant. Starting at a local weak point, the attack may spread rapidly from the initial weak point along the boundary between the sulphide and ferrite. At the same time, however, an undermining of the surrounding protective film will occur, and, due to weak adhesion or some other capillary phenomenon, the film will be broken up around the central particle. The intervening space becomes filled with solution and also to some extent with hydrated oxides, thus explaining the presence of interference fringes; the occasional contraction and expansion of the fringes may be due to a temporary alteration in the thickness. The area under the loosened film being screened from any depolariser is anodic, and the iron ions can only escape through the central opening. During corrosion the dimensions of the ring cavity increase, and at the same time the polished anodic surface under the interference rings is also attacked, reducing its reflecting power. This may be the explanation of the lack of brilliance and the broken interference rings at the anodic areas in Fig. 4. The disintegration of the central inclusion may be due to the anodic attack upon the material which cements the constituents—a possibility deserving special attention where a eutectic or eutectoid is present at the grain boundaries.

The anodic corrosion at places of major weakness must produce alkali at cathodic places elsewhere. Using phenolphthalein, Homer has actually detected the appearance of a distinct pink colour at the unattacked areas of the surface. This alkali reacts with ferric or ferrous ions from the anodic areas, forming the rust ring. Clearly the alkali will tend to heal up the incipient attack at places of minor weakness, as the hydrated ferric oxide here will be precipitated in physical contact with the metal and will protect it against further attack. The absence of rust particles at certain weak places may be due to such a healing process. According to Evans, this may also explain why only a certain number of the sulphide inclusions show localised attack; at the others, rapid healing may have occurred.

The depolarisation of hydrogen by oxygen or chromate is undoubtedly the main cathodic process. But in addition to this oxygen-absorption type of corrosion, the hydrogen-evolution type may be operative. The liberation of hydrogen during the corrosion of iron and steel in neutral salt solutions has been detected by several investigators. The process will take place mainly at acid centres of low over-voltage. The present investigation suggests that the active sulphide inclusions can constitute such centres. The low over-voltage may be attributed partly to the porous structure of the sulphide, whilst the high concentration of hydrogen ions may be due to the hydrolysis of ferric salts. In a previous Paper by one of the authors, the acid reaction at active anodic centres on aluminium was detected by means of indicators; here the formation of acid was attributed to impurities of an acid character, and the possibility of its formation through the hydrolysis of aluminium ions was overlooked.

Summary and Conclusions.

The corrosion of ferrous materials with different phosphorus and sulphur contents in 2*N* sodium chloride, containing oxygen or chromate, has been examined by measurements of the weight loss and oxygen absorption, as well as by microscopic and micro-analytical methods. In ordinary iron and steel, phosphorus produces no appreciable effect, since it is present mainly in solid solution. A certain number of sulphide inclusions, however, initiate the anodic attack of the metal immediately around them and thus stimulate localised corrosion. It is important to point out that a large proportion of the sulphide particles are nearly or completely inactive; the active character of the others may be due to the presence of crevices. The active sulphide inclusions seem to act as cathodes for corrosion of the hydrogen-evolution type, whereas in corrosion of the oxygen-absorption type, which is of greater importance, the cathodic process occurs at the main (uncorroded) area.

Messrs. Workman Clark (1928), Limited, have booked a contract for the overhaul of the Ellerman Line steamers "City of Oran" and "City of Eastbourne." This is in addition to the existing contract for overhauling other City liners, the first of which has already reached Belfast. The overhaul is to include in each case the fitting of exhaust turbo-electric drive in combination with the existing reciprocating machinery. The firm has also booked an order for overhauling the Anglo-American Oil Company's tanker "Tamarse."

Better Copper Outlook.

By "ONLOOKER."

After months and months of existing under a cloud, copper is beginning to come into the limelight again, for there is increasing evidence that at long last the red metal is beginning to fight its way back to a more remunerative level. It will be remembered that the beginning of the long fall from 18 cents began in April, 1930, and that the bottom was reached in July last, when Japanese copper was sold in Europe at 4.60 cents, c.i.f.; from that point a rapid recovery set in, all of which, however, was not maintained, for on a setback values again came down to 4.90 cents, and it was not until the "shutdown" announcement was made early this year that the market definitely turned its back on 5 cents. Lack of demand has, of course, been a contributory factor in depressing the price of copper, but the greatest harm has been caused by the presence of such huge unsold stocks in the United States.

Although the sensational improvement we have seen in copper values has been brought about by the American policy of inflation, a change for the better had already come before the United States took their drastic step in abandoning gold, and although the closing down of mines in the U.S.A. has been abandoned, there still remains among producers in that country the conviction that something must be done to put the statistical position into better shape. Of the "big three," Kinnecott and Phelps Dodge have already decided to limit their output to but 10 per cent. of capacity, and it must be presumed that Anaconda will follow. Actually, of course, many mines in the United States have closed down probably for ever, and were it not for the excessive stocks, production would be already at a level which approximately balances consumption. How are these stocks which have been mortgaged to the banks to be looked after? Much of the copper was pledged when the price was 11 cents per pound, and in view of the serious losses which some of the companies have made, it is not surprising that the banks are getting restive.

The most recent suggestion is for a copper pool to look after the surplus until such time as consumption improves to the point of taking up this metal, and negotiations to this end are taking place in New York. Of the result of these discussions the market seems to be rather sceptical, but it does appear to an unbiassed view as if the mining interests in America have made up their their minds that in spite of an improvement in the price it is necessary to take steps to correct what is decided by a top-heavy state of affairs. They are perhaps the more inclined to take action because the trend of political events in their country to-day is rather "anti-tariff," and it is believed that Mr. Bennett is doing his best to secure an opening for Canadian copper into the States. It is not yet twelve months since the 4 cents duty was put on and probably its life of two years will not be shortened, but producers have already realised that this taxation of foreign copper is not doing for them all that they hoped.

As far as copper is concerned one can say with a fair degree of safety that there has been a change of heart on the part of investors, whether in the shares of mining companies or, through the medium of the Metal Exchange, in the metal itself. Not so very long ago anything below 5 cents was considered cheap, and to-day one can say that 7 cents has replaced 5 cents as the mean level for the red metal. Consumers have not yet quite come round to this view, but this realisation will dawn before long as it is understood more clearly that copper has taken a definite step towards a rather better quotation, and there can be no doubt that the prospects for copper are greatly improved.

XUM

Pig-Iron with Higher Manganese Content.

By J. L. Francis.

An examination of the specifications and stock lists issued by the numerous producers and suppliers of pig-iron will disclose the fact that irons containing a regular manganese content of 1.5 per cent. and over are very few indeed. From this one concludes that appreciation of the extremely valuable advantages to be derived from employment of these irons in grey-iron mixtures is lacking amongst metallurgists and founders as a whole.

Lack of Manganese in Castings.

It is not too much to state that, with certain notable exceptions, pig-irons are offered to the foundryman with manganese contents ranging about the correct percentages that should appear in the resulting castings. Neglecting the effect of the tendency of scrap charged with the pig to reduce this figure, there is always a reduction of manganese by oxidation during melting. With average cupola practice this loss may be taken as 20 per cent. of the total amount of manganese as charged. It follows, therefore, that the majority of castings would benefit by an increase in manganese content of at least 20 per cent. more than the amount that they actually do contain.

This apparent failure to recognise the benefits that may be derived from pig-iron with higher manganese content is the more surprising in view of the widespread publications dealing with the influence of this element on cast iron. Very valuable and enlightening investigations have been made into this field, and some of them are to be referred to later.

Manganese Additions.

In many cases where the importance of increased manganese content in iron castings is realised the extra additions have to be obtained by the use of ferro-manganese, spiegeleisen or manganese-bearing briquettes. None of these alternatives offers the convenience, exactness or reliability that is obtained by the use of pig-irons having a sufficiency of manganese in them initially. Manganese loss in remelting is far greater and less constant when the element is charged in the concentrated form. Moreover, it is more difficult to get it evenly distributed throughout the charge, and it may not come down in the charge intended at all. The difficulty of uniform distribution and extra supervision is also present where manganese is added to the melt by means of ladle additions. Here also limitations are imposed as to the quantities of addition that can safely be made by the tendency towards temperature reduction of the iron unless the additions are made in the pre-heated or molten condition. For ladle additions this latter method is perhaps the most desirable way, as the usual manganese alloys are not easily taken up in molten cast iron when added cold.

Drastic Hardening Action a Fallacy.

It is possible that the antipathy towards pig-iron of higher manganese content is in no small degree due to the widespread and firmly-rooted belief that manganese, say, above 0.75 per cent., is a drastic hardener of grey iron, but in ordinary irons this belief is by means well founded. Coe[1] made a series of bars with manganese contents varying from 0.55 to 30.0 per cent., finding no great reduction in graphite until a manganese content of over 3.0 per cent. was obtained. Similarly Hamasumi[2] found little difference in combined carbon until manganese was over 3.0 per cent. Dr. Norbury,[3] too, has investigated the influence of manganese in cast irons in a very exhaustive manner and confirms the results quoted. In fact no better advice can be given to those desiring to know more of the influence of manganese in all types of iron castings than thoroughly to study Dr. Norbury's Paper in its entirety. Furthermore, the author,[4] in examining the effect of chemical composition on the structural volume analysis of high-duty cast irons, found as follows:—"Very little difference is made in the volume composition by a rise or fall of manganese content. This is only to be expected, for more or less of a balance is struck by the amount of total carbides formed. When the manganese becomes less, more iron carbide results, and when the manganese increases more manganese and less iron carbide is formed. The net result being approximately a constant quantity of carbide is available for formation of pearlite and the other constituents are not directly influenced."

Then, too, H. H. Shepherd[5] has written:—"In passing it may be of interest to mention that in the writer's opinion the beneficial effect of a reasonably high percentage of manganese is not appreciated or utilised to anything, like the extent it should be by most foundrymen. Many castings having a manganese content of 0.5 per cent. could without any danger of trouble have safely carried 0.9 to 1 per cent., which would give a tougher and also harder wearing iron."

Danger of Lack of Manganese.

The remarks so far go to show that there is no real difficulty or drawback resulting from the use of pig-iron with higher manganese content. It remains now to show that there are many important reasons for its more wide-spread use in iron founding generally. A consideration of the influence of manganese in cast iron must be coupled with that of sulphur. Iron containing sulphur and no manganese has the sulphur present as ferrous sulphide. Ferrous sulphide is soluble in iron carbide to a small extent, imparting to it a great resistance to break down. The drastic hardening and chilling action of sulphur is most probably due to this fact and is far more powerful in this respect than any such action arising from an excess of manganese. However, only a small part of the total sulphur as ferrous sulphide is absorbed by the carbide, by far the greater part of it going to form a new constituent of ferrous sulphide and iron. The latter is really an eutectic having a melting point below that of the cast iron itself. Hence when the sulphide eutectic is present it tends to surround the metal grains preventing metal to metal contact so essential to strength. The sulphide eutectic itself is hard and brittle, and, when situated as mentioned, the cast iron breaks off short at the grain boundaries at very low stresses. Castings containing ferrous sulphide eutectic are also very liable to failure if used at elevated temperatures due to the softening of this constituent. Other most undesirable features of the sulphide eutectic are its relatively high specific gravity of about 5 compared with that of cast iron about 7.3 Thus it exhibits little tendency to rise to the top of the melt in the ladle and remaining still mobile after the iron has solidified becomes entrapped.

Manganese-Sulphur Balance.

In the presence of manganese in sufficient excess manganese sulphide forms in place of the iron sulphide mentioned above. For a variety of good reasons, to be given subsequently, manganese sulphide can be shown to be preferable to ferrous sulphide and consequently that manganese is an element greatly to be desired as a constituent of pig, grey and malleable cast irons.

Dr. Norbury, in his work already referred to, shows that for a sulphur content of 0.1 per cent., manganese in the proportion of 0.17 per cent. is necessary in order to convert the sulphur to manganese sulphide. The proportions are theoretically correct allowing no surplus of either constituent. Iron, however, as discussed above, also shows an affinity for sulphur and if the proportion of manganese present is only sufficient to satisfy the theoretical requirement iron sulphide forms as well. Some of the manganese, too, is shared with the carbon to form manganese carbide, as stated previously. These two effects offset the attraction of manganese for sulphur to some extent, so that to ensure that all the sulphur combines with the manganese an excess of the latter element over theoretical requirements must be present. Dr. A. L. Norbury has found that the manganese must be increased by 0.3 per cent. above the theoretical minimum before the whole of the sulphur is compelled to form manganese sulphide. His rule, therefore, is that the manganese content must be at least 1.7 times the sulphur plus 0.3 per cent. When this requirement is fulfilled, an iron is said to be balanced by manganese with respect to its sulphur content. Various statements have appeared at different times in the past giving the manganese rates in terms of the sulphur present for best results with special types of casting. The above rule has now summarised and reconciled the majority of these.

Cleansing Action of Manganese.

Unlike iron sulphide eutectic, manganese sulphide has a higher melting point than cast iron so that it becomes solid before the iron itself has solidified. Where present in castings, therefore, it does not soften and cause failure under heat as does the former constituent. Also as the melt remains fluid long after the manganese sulphide has solidified it tends to rise to the top with the slag. Its lower specific gravity of about 4 also helps it to act in this way. Herein lies an explanation of the well-known fact that molten iron if allowed to stand will cleanse itself.

Sulphur Pick-Up.

There is always a tendency for the sulphur content to increase by pick-up from the coke. An average value for such increase on remelting in the cupola is 0.02 per cent. At the same time the 20 per cent. loss of manganese content by oxidation must also be borne in mind. It so happens that from the point of view of successful founding these two facts work together to its disadvantage. From this it is easily understood that although a cast-iron mixture may be balanced with respect to its sulphur at the time of charging it certainly will not be so balanced after passing through the cupola. The importance of pig-irons with higher manganese content is disclosed in this fact. An appreciable amount of manganese in excess of the balanced requirements is essential in the initial charge. Scrap must be used in the metal charges, not only for economic reasons but also for its refining action on graphite and the grain size. Then, too, the lower the silicon content being worked to, the higher is the resulting sulphur percentage likely to be. Therefore, unless this tendency of sulphur to increase is very carefully watched and counteracted trouble sooner or later is bound to arise. With a sufficient excess of manganese always present there is a most effective safeguard. Where this practice of always ensuring a surplus of manganese over the manganese-sulphur balance is adhered to, there is no need for any other desulphurising practice, especially when a limestone addition of about 30 per cent. of the coke charge is also a regular procedure.

Higher Scrap Ratios.

For the past 10 years the author has based his metal practice on the use of basis pig-irons of higher manganese content with nothing but the most satisfactory results. If the method as outlined be adopted, scrap ratios as high as from 70 to 75 per cent. of the metal charge may be

(*Concluded on page* 418.)

Colbond* in the Foundry.

By J. Thompson.

Sand is a very important factor in the production of good castings, especially in these days of mass-production foundries producing high-grade castings. There are in use many types of castings and alloys to be used for these castings, each of which requires individual consideration as regards methods of melting, moulding and casting.

The need of high production in the foundry brings into operation an increasing use of moulding machines, operated by unskilled or semi-skilled labour. These men may have little or no knowledge of moulding sands. The moulder's job is to make good moulds, and for this he must be supplied with suitable sand. It is not economical for each moulder to prepare his own sand, and it is therefore essential to have a good supply of prepared sand, which should be as uniform as possible as regards permeability and bond. Keeping the sand uniform removes one of the variable factors in making castings, and the elimination of variable factors is essential in the successful production of castings, particularly in mass-production foundries.

Many foundries use naturally-bonded sands, largely a result of tradition and the fact that there are plentiful supplies of sand with a natural bond, which, however, vary in quality in different districts. Synthetic sand consists of a moulding sand built up according to the requirements of the particular foundry. The essential constituents of a moulding sand are: (1) Silica grains to give a base material of a refractory nature and (2) bonding material to enable the silica grains to bind together for the purpose of making a mould of sufficient strength for withdrawing the pattern and the subsequent casting of the metal.

Nature of Moulding Sands.

Most bonding materials in use are of a clay nature, which requires a certain amount of water to give the necessary plasticity. It will be realised that the presence of water will give rise to steam on casting, and the sand will therefore have to be sufficiently permeable to allow such gases to escape freely from the mould.

Silica sand is obtained from two or three sources. It is either quarried, obtained from the sea shore or from the river bed. The best type of sand is one which has rounded grains. Sea and river sand usually have rounded grains, but also contain a large percentage of shell. The shell, which is calcium carbonate, tends to fuse at a much lower temperature than the metal, and would impair the permeability of the sand. The raw sand, should, therefore, be composed of rounded grains and contain a minimum quantity of shell, if any.

Sand is composed of different-sized grains, and where the variation is too great, low permeability ensues. The smaller grains of sand pack in between the larger grains and reduce the effective passage way for the gases. To show the size of the grains, either a sieve test or an elutriation is carried out. The sieve test is made by sieving a known weight of dried sand through varying meshed sieves. The sand is introduced into the coarser sieve, and those grains which pass through are similarly passed through finer-meshed sieves. The sieves are given numbers, indicating the number of wires per sq. in. or in some cases the size of the holes in the sieve, the lowest number being the coarse sieve and the highest number the fine sieve. The sand which is retained on a sieve is given a positive (+) sign, and that which passes through, a negative (−) sign. The more accurate method for the finer grades of sand is the elutriation (or water-grading) method.

Permeability.

To show the permeability of the different grain sizes, a quantity of dried sand is separated into its various grades. Each grade is first mixed with a constant percentage of water and then repeated with the addition of a known weight of clay bond. Ten parts of the sand were used to 3.5 per cent. water, and one part of bond. The permeability in the case under consideration was measured by the A.F.A. method, *i.e.*, a high number indicates good permeability and a low number indicates poor permeability. The bond strength was also measured by the A.F.A. method. The clay bond used was a special clay known as "Colbond." The results are set out in Table I.

TABLE I.—*Influence of Colbond on Permeability and Bond Strength.*

Without Colbond.		With Colbond.	
Grain size.	Permeability.	Permeability.	Bond strength.
+ 20–30 ..	850	492	2.8
+ 30–40 ..	520	341	3.2
+ 40–50 ..	380	280	3.9
+ 50–60 ..	287	203	4.1

Although the moisture content was constant, the coarser sands appeared to be much wetter than the fine, due to the larger surface area of the fine sand. The raw sand should be composed of a large percentage of equal-sized grains, the size varying with the grade required, *i.e.*, coarse or fine. For heavy castings, the fine sand would tend to fuse, and the coarse sand would produce a rough skin for light work. Two typical sands in use in one large foundry in this country are given below:—

Grain size.	Coarse.	Fine.
	Per cent.	Per cent.
+ 60	72.9	15.0
+ 80	24.8	20.0
+ 120	1.9	31.9
+ 150	0.2	13.3
+ 200	0.1	9.8
− 200	0.1	10.8
Permeability A.F.A. ..	250 to 300	70 to 90

Suitable Bonds for Synthetic Sands.

Having obtained the sand, the next step is to find the bonding material. Clay appears to be the most popular as bonding material for synthetic-moulding sand, there being several special clays in use. The clay is dried, crushed and ground to an extreme fineness, 90 per cent. passing through a 200-mesh sieve. The clay mixes very easily and quickly, due to being dry and finely ground. A recently discovered bonding clay, which is meeting with pronounced success, is Colbond. Colbond is mined in the British Isles, and possesses a much higher plasticity than most clays, consequently, but little is necessary to give the required bond. To be plastic and sticky, water must be added to the mixture of clay and sand, and the less clay used the less the amount of water required. Therefore by using Colbond the percentage of moisture is considerably reduced, and there is less danger of blown castings. Naturally-bonded sands are worked at about 6 to 7 per cent. moisture, whilst synthetic sand only carries 3 to 4 per cent. With Colbond the sand can be used almost dry and still have a good bond strength.

Water should always be kept to a minimum. Up to a certain figure water increases the bond strength, but when this figure is exceeded a lower bond strength is obtained.

The following figures show the influence of increasing water content in synthetic sand:—

Percentage moisture.	Bond.
1	0.8
2	4.3
3	7.9
4	6.4
5	5.2
6	4.9

In mixing Colbond there are no lumps of clay to be crushed, therefore there is no necessity to have a roller attached to the mill. The oil-sand type of mixer provides a good machine for the mixing. The kneading action of the paddles mixes the clay evenly. The time required is about two minutes.

The Colbond sand gives many advantages as compared with naturally-bonded sands, such as:—(1) Less moisture required, (2) easier mixing, (3) maximum spreading of the bond through the sand and (4) transport and storage of Colbond only 10 per cent. of the cost as compared with using naturally-bonded sands.

In milling a natural sand the time taken is from ten to fifteen minutes. With Colbond sand there is a huge saving in time and power. The extra milling means extra labour and more power to work the machine in order that the lumps of clay may be broken up and distributed evenly in the sand. By using Colbond more accurate control can be kept over the clay content of the sand, as natural sand is variable in quality and quantity of bond, and also moisture content.

Another great advantage is the fact that the amount of new sand added is kept down to a minimum. In the foundry using natural sands, the sand increases rapidly in bulk, due to the amount of new sand required to give the necessary bond strength to the sand. With Colbond the addition is much smaller, consequently the amount of sand does not grow nearly so quickly.

Colbond sands are easily controlled as regards permeability, bond and moisture. The sand should be daily checked for grain size, bond strength and also for permeability. If the permeability falls, it is usual to check the grain size. If the grain size decreases, more new sand is introduced into the system. Over a period of four months' observations in one large foundry where Colbond is used, the sand was fairly constant, as is shown in Table II.

TABLE II.—*Life of Sand using Colbond.*

Grain size.	Start.	Four months later.
	Per cent.	Per cent.
+ 30	6.8	5.2
60	54.2	47.4
80	19.6	23.4
120	14.6	17.8
150	4.0	3.4
200	0.7	1.0
− 200	0.7	1.0
Permeability ..	78.0	63.0
Bond	5.8	7.6
Moisture	3.3	3.8

The above results show quite clearly that the sand can be kept in a satisfactory condition as regards strength and permeability at a low moisture content by using Colbond as a bonding material. Using naturally-bonded sand the facing sand is often composed of 33 to 50 per cent. new sand, while with synthetic sand the facing is usually 10 per cent. new silica sand and 3 per cent. Colbond, the remainder being old sand.

Colbond is being marketed from 24, Martin Lane, Cannon Street, London, E.C.4.

* Colbond, we understand, to be a definite natural mineral entity.—EDITOR.

Mechanical Testing of Steels at Low Temperatures.

At a meeting of the Institution of Chemical Engineers, held in London on May 24, Dr. Herbert Levinstein (Vice-President) in the chair, Messrs. E. W. Colbeck, W. E. MacGillivray and W. R. D. Manning read a Paper on "The Mechanical Properties of Austenitic Stainless Steels at Low Temperatures,"

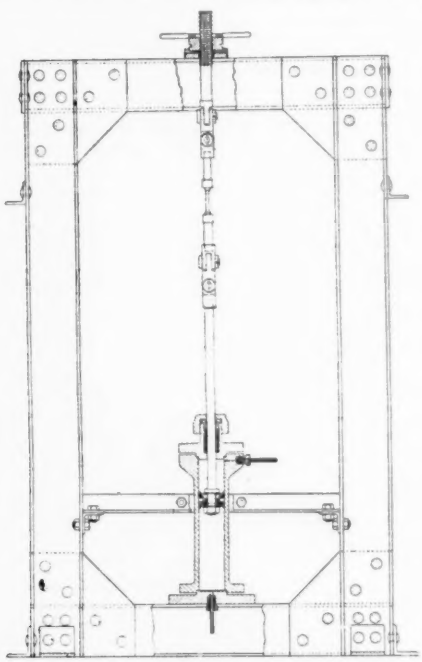

Fig. 1.—General Arrangement of Machine.

in the course of which they described a special hydraulic machine which they had to construct for testing large numbers of specimens in low-temperature baths. The machine could apply a maximum load of 6 tons, although it later proved capable of greatly exceeding this figure. The authors' description of the machine is as follows:—

It consisted of a massive rectangular framework built up of channel sections with a hydraulic cylinder fixed in the base. The upper anchorage of the straining mechanism was a screw-jack passing through a block of steel mounted on the top transverse member of the frame. Screw connections were used to hold the specimen and these were made of Monel metal, because Donaldson had found that it had a low thermal conductivity at room temperature, which decreased with falling temperature in the range 400 deg. to 100 deg. C. It proved very successful, and with a shank 4¾ in. long by ⅜ in. in dia. maintained a very large temperature difference without involving a heavy consumption of liquid air. To ensure axial loading, two flexible pin joints at right angles to one another were introduced above and below the specimen. These pieces were also made of Monel metal with the exception of the pins, which were of hardened steel.

The hydraulic cylinder was arranged so that it could apply either a tensile or compression stress to the specimen. The maximum working pressure was 1 ton per sq. in. The general arrangement of the hydraulic mechanism is shown in Fig. 1. Valves of the type designed for high-pressure work in the University of Leiden proved entirely satisfactory, and were arranged as shown in Fig. 2.

For straining in the elastic range a hand-operated pump was adequate, but for a complete test to destruction a more continuous-pressure supply was necessary. The authors were fortunate in being able to use a special motor-driven pump, consisting of two single-acting rams of small capacity, capable of delivering against pressures of 2 tons per sq. in. These rams had quick-return motions which enabled the first ram to finish one working stroke and begin another, while the second was still making one working stroke, thus making the action continuous.

Impact Testing at Low Temperatures.

The authors also stated with regard to impact testing that the tests were carried out in a standard 120 ft.-lb. Izod pendulum machine, into the vice of which the specimens were rapidly fixed, after being brought to a low temperature by immersion in a cooling bath. Previous experiments with drilled specimens of austenitic and mild steels, in which a thermocouple had been inserted, showed that no sensible rise in temperature occurred in the neighbourhood of the notch, if the operation of taking the specimen from the low-temperature bath and clamping it in the vice did not occupy more than seven seconds.

In the course of a discussion which followed the reading of the Paper, Dr. A. Michels asked at what rate the tensile tests were carried out, because in the course of tensile tests a certain amount of heat was developed, so that unless special precautions were taken there might be variation of the temperatures at which the different specimens fractured. Another reason for special precautions in this connection was that the austenitic steels had different heat conductivities.

Mr. E. W. Colbeck, in reply, said that the tensile test-pieces had fractured at different temperatures, owing to heat generated during the tests, and pointed out that in these tests there was pentane around the specimen in some cases and liquid air in others. Further, a thermocouple was strapped to the middle of each piece during test, and there had been no indication of

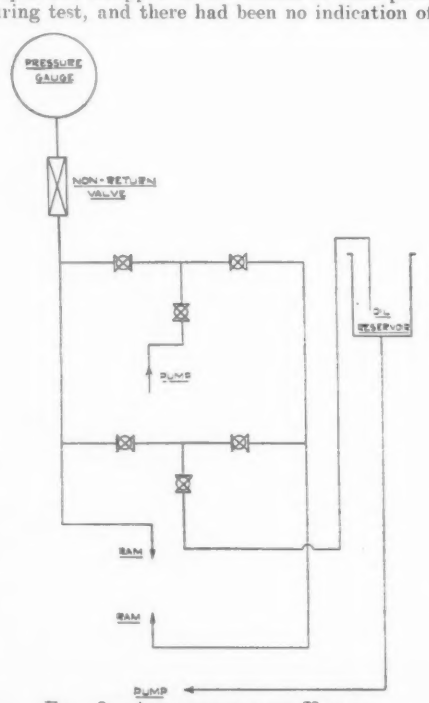

Fig. 2.—Arrangement of Valves.

heating. With regard to the different heat conductivities of the different austenitic steels, he suggested that if there were any variable of that sort it would be shown up by sharp breaks in the curve of the tensile strength for the different materials.

Pig-Iron with Higher Manganese Content.

(*Concluded from page* 416.)

run day after day, indefinitely without any sign of sulphur trouble. In these days of fierce competition this is a most important consideration for producers of iron castings from cupola-melted metal. Again the main feature of success is emphasised, namely, pig-iron of higher manganese content. Buy to a definite specification a basis pig-iron wherein the silicon and manganese contents must not drop below a minimum figure. As already pointed out, this is not so much because of desiring to obtain particular or exact percentages of these elements in the finished castings, but mainly to ensure that no deficiency of them shall occur. The larger the scrap ratio and the greater its unknown composition and variability, the more necessary is it to be able to rely on the pig-iron absolutely, so that its corrective influence on the charge may be ensured.

Higher Manganese Content Characteristics.

These few notes make no pretence of dealing with the effects of sulphur and manganese on cast iron in an exhaustive manner. They are merely intended to indicate the advantages of working with higher manganese contents on the resulting products. The authorities quoted and also many others not mentioned have expounded the subject much more fully and ably. That the benefits of manganese should be more easily available in pig-irons generally, and the advantages attending its inclusion in castings more widely appreciated, are the chief points it is wished to bring out. As a final effort to this end a summary of some of these benefits and advantages arising from percentages of manganese in excess of the sulphur manganese balance may not be out of place. They include:—(1) Self-cleansing action of the metal; (2) neutralises and slags off the sulphur; (3) deoxidises the melt; (4) imparts extra fluidity; (5) densens and closes the grain of the metal; (6) removes tendency for occurrence of hard spots; (7) facilitates machining; (8) castings possess a more silvery appearance and take on a better finish; (9) imparts toughness and better-wearing qualities: and (10) diminishes tendency towards defects caused by occluded gases.

BIBLIOGRAPHY.

1 Coe: "J.I.S.I.," No. 2, 1910.
2 Hamasumi: "Science Reports, Tohoku Imperial University, 1924," Vol. 13, pages 133–178.
3 Dr. Norbury: Foundry Trade Journal, August 1, 1929, page 79.
4 J. L. Francis: "Iron and Steel Ind.," December, 1927, page 88.
5 H. H. Shepherd: "Met. Ind.," February 5, 1926, page 138.

Successful Finishing of Die Castings.

(*Concluded from page* 412.)

somewhat higher temperatures; yet even here care must be exercised so as not to exceed a safe baking point, or the casting will crystallize and become brittle.

Operators should be careful to see that the temperature at which the finishing material is baked should always be slightly lower than the preheating temperature. In some cases die castings can be baked as high as 350 deg. Fah., whereas other cast parts will not stand more than 224 deg. Fah. Experiments on the particular die castings to be finished will reveal the maximum and safe heating temperatures.

It should be borne in mind that the composition of the priming coat has considerable bearing upon the completed work. Especially desirable results have been achieved on zinc and aluminium die castings with certain red metal primers containing considerable iron oxide in combination with appropriate oils and varnishes.

Notched-Bar Tests.—In a Paper read by E. Starck before the 12th annual meeting of the German Association for Testing Materials in Czecho-Slovakia, the author discusses the evolution and present position of the notched-bar test. This Paper has now been reprinted in the HDI-Mitteilungen des Hauptvereines deutscher Ingenieure in der Tschechoslowakischen Republik.

This Week's News in Brief.

Trade Talk.

THE SUMMER MEETING of the Institution of Heating and Ventilating Engineers is to be held at Llandudno on June 19, 20 and 21.

THE EMPLOYEES of Messrs. Babcock & Wilcox, Limited, at Dumbarton Works, have contributed the sum of £101 to infirmaries and other charities.

THE GRANGEMOUTH IRON COMPANY held a jubilee dinner at Falkirk on Saturday, June 10, to commemorate the 50th anniversary of the founding of the company's Grange Ironworks.

BANKERS COMMERCIAL SECURITY, LIMITED, have changed their address from Regent Arcade House, 252-260, Regent Street, London, W.1, to 17-19, Stratford Place, Oxford Street, London, W.1.

AT THE LAST MEETING of the Glasgow Chamber of Commerce the Grange Foundry Company, Limited, of Shettleston, and the Thistle Nail Works, Wishaw, were admitted to membership.

THE CLYDE NAVIGATION TRUSTEES have decided to order three new ferry boats of a design similar to one built in 1928, each with accommodation for 140 passengers. Specifications are being submitted to Clyde shipbuilders and tenders asked.

THE SCOTTISH NATIONAL DEVELOPMENT COUNCIL have arranged to be represented when the Scottish Trade Mission ship sails for Scandinavian and Baltic ports. The Council has decided to collaborate in every way possible to ensure the success of the project.

WHILE WORKING at the foundry of Messrs. John King & Company (Leeds), Limited, ironfounders, of Hunslet, Leeds, Mr. Jack Sylvester was burnt by an overflow of molten metal. He was taken to the Leeds Infirmary suffering from burns to the face, arms and chest.

WE UNDERSTAND from Messrs. Sturtevant Engineering Company, Limited, 147, Queen Victoria Street, London, E.C.4, that they have recently received an order for the installation of a Sturtevant electrostatic precipitator to deal with the noxious vapours from an industrial process.

MESSRS. R. Y. PICKERING & COMPANY, LIMITED, Wishaw, have secured a large contract from the L.M.S. Railway Company for the construction of between one hundred and two hundred meat containers of a special type. The order will keep the works going at full capacity for some months.

A STRIKE at the works of Messrs. Henry Hope & Sons, Limited, metal window-frame manufacturers, at Smethwick, which began 11 weeks ago as a protest against the introduction of the Bedoux system, ended on Monday. An overwhelming majority of the strikers agreed to resume work on the employers' terms, which include an undertaking to discuss the points at issue when work is resumed. A thousand men have been involved.

IT IS ANNOUNCED by the L.M.S. railway company that the two new steamers "Mercury" and "Caledonia," which have been ordered from Messrs. William Denny Bros., Limited, Dumbarton, and the Fairfield Shipbuilding Company, Limited, will each have a passenger certificate for 1,500 passengers, and will be 220 ft. between perpendiculars, with a breadth moulded of 30 ft., depth moulded 10 ft. 3 in., and a speed of 17 knots. Both vessels will be ready for service on the Firth of Clyde in the 1934 season.

IN ADDITION to the three passenger ferries for which tenders are being invited by the Clyde Trust, a number of other inquiries are being dealt with by Clyde builders. A Dutch firm who have had a number of ships built on the Clyde are in the market for a passenger and cargo motorship for service in the East. The vessel is to have twin screws and engines developing 8,000 b.h.p. There are also a number of inquiries for coasting vessels, one small passenger and cargo motorship, for which estimates have been asked by an Australian firm.

AT KILMARNOCK SHERIFF COURT, Messrs. Colvilles, Limited, Glengarnock Iron & Steel Works, were charged at the instance of H.M. Inspector of Factories with having neglected to observe a section of the Factory and Workshop Act, 1901, in that a certain dangerous part of the machinery in the factory where an accident had happened to an employee, was not either securely fenced or in such a position or of such construction as to be safe to persons engaged in the factory. After evidence had been heard at considerable length, the charge was found proven and a fine of £5 imposed with £3 10s. expenses.

MESSRS. YARROW & COMPANY, LIMITED, Scotstoun, launched the torpedo-boat destroyer "Lima," the second of the five torpedo-boat destroyers ordered from Messrs. Yarrow & Company by the Portuguese Government. The naming ceremony was performed by Madame Meyrellas. The "Lima" is 322 ft. long by 31 ft. beam, and the armament consists of four 4.7-in. guns, three anti-aircraft guns, two quadruple torpedo tubes, as well as a complete system of fire control and arrangements for mine laying. The machinery consists of two sets of single-reduction turbines with latest-type Yarrow boilers, superheaters and air heaters. The vessel is designed to have a speed of 36 knots.

THE INSTITUTION OF MECHANICAL ENGINEERS held their summer meeting in Scotland last week. It is 46 years since the Institution visited Edinburgh, the previous visits being in Glasgow in 1923 and Aberdeen in 1907. The programme included official welcomes by the city and the University of Edinburgh, visits to places of interest and works in the Edinburgh district, and a civic reception in the City Chambers. The party paid a visit to Dundee on May 31, where a civic welcome was accorded them and the Freedom of the City was conferred on Sir Alfred Ewing, an honorary life member of the Institution. Visits were paid to the Grampian Hydro-Electric Works, Messrs. Bruce Peebles & Company, Limited, Portobello Power Station and to the Border Country.

New Companies.

R. B. Hilton, Limited, 7, Blackheath Chambers, Blackheath Village, London, S.E.—Capital £5,000 in £1 shares. Engineers, founders, etc. Permanent governing director: R. B. Hilton.

George C. Siddons, Limited.—Capital £15,000. Ganister manufacturers and merchants. Directors: G. C. Siddons, Warren House, Normandale, Loxley, Sheffield; C. W. F. Siddons and Wm. Siddons.

R. J. Coley & Atkinson, Limited.—Capital £2,000 in £1 shares. Metal and machinery merchants, etc. Permanent directors: E. D. Atkinson, 17, Upper Park Road, Kingston-on-Thames, and Mrs. A. Atkinson.

Metal Penetrations, Limited.—Capital £1,000 in £1 shares. Metallurgists, manufacturers of and dealers in metal alloys and ores, etc. Directors: A. H. Kempton, 19, Arthur Road, Wimbledon, London, S.W.; W. E. Holland and C. E. Curr.

Company Reports.

Falkirk Iron Company, Limited. — Profit, after providing £7,170 for debenture interest and £3,461 for depreciation, of £133, increasing the amount carried forward to £42,311.

Darwins, Limited.—Profit, including £2,000 from reserve for income tax not now required, £10,903; provision for losses on subsidiaries, £9,548; net profit, £1,355; debit balance carried forward, £2,742.

Whitehead Iron & Steel Company, Limited.—Net profit for year ended March 31, £52,575, after making provision for debenture and other interest, and all administration and other expenses, placing £20,000 to depreciation reserve and £6,800 to income tax reserve. The directors recommend that the expenses of issue (including discount), amounting to £9,594, incurred in connection with the issue of first mortgage debenture stock, should be written off, that £10,000 should be placed to general reserve, and the payment of a final dividend of 7½ per cent (actual), making 12½ per cent. for the year.

Contracts Open.

Cairo, July 10.—Diesel pumping set, for the Ministry of Public Works. The Department of Overseas Trade. (Reference G.X. 12,655.)

Johannesburg, July 14.—Turbine-driven alternator set, for the Rand Water Board. The Department of Overseas Trade. (Reference A.Y. 11,835.)

Rhondda, June 26.—Two static transformers, for the Urban District Council. Mr. J. M. Bowman, electrical engineer, Electricity Works, Porth, Rhondda.

Personal.

SIR FREDERICK GEORGE PENNY, M.P., a director of Consolidated Tin Smelters, Limited, and of the Eastern Smelting Company, Limited, has been made a Baronet.

MR. JOSEPH HEPWORTH, M.P., of Messrs. Hepworth & Grandage, Limited, of Bradford, is making satisfactory progress following his recent operation for appendicitis.

MR. N. B. SAKLATVALA, chairman of Messrs. Tata Sons, Limited, Bombay, and of the Tata Iron & Steel Company, Limited, receives a knighthood in the King's Birthday Honours list.

DR. GEORGE CHRISTOPHER CLAYTON, J.P., M.P., a director of Imperial Chemical Industries, Limited, and President of the Institute of Chemistry, is one of the new Knights Bachelor whose names appear in the King's Birthday Honours list.

MR. A. H. MOORE, of the Standard Brass Foundry, Benoni, Transvaal, South Africa, and honorary corresponding member for South Africa of the Institute of British Foundrymen, is at present in England, and hopes to take part in the Cardiff Convention.

MR. W. BRUCE has retired from the post of commercial manager of the United Steel Companies, Limited, properties in West Cumberland, and is succeeded by MR. LANGTON HIGHTON, a son of the late Mr. R. E. Highton, who himself occupied that position in the days of the Moss Bay and Workington Iron & Steel Companies.

MR. OLIVER SMALLEY, the internationally-known metallurgist, is at present staying in England, and hopes to participate in the Cardiff Convention. Mr. Smalley is the President of the Mechanite Corporation, consulting engineer to the Crucible Steel Company of America, the technical director of the Gray Iron Institute, and British Vice-Consul at Pittsburg. Correspondence for Mr. Smalley, addressed to this office, will be forwarded to him.

EX-PROVOST JAMES K. SHANKS, Beechfield, Denny, and chairman of Messrs. Cruikshanks & Company, Limited, Denny Iron Works, was the guest of honour at a public dinner in the Masonic Hall, Denny, on May 30. Provost Loney, who presided, said that when Mr. Shanks retired from the Town and County Councils it was fitting that there should be some tangible recognition of his services and of the high appreciation of the community whom he so faithfully served. The intention was that personal gifts should be presented to Mr. and Mrs. Shanks, but on approaching the ex-Provost, he in his usual unselfish manner expressed a desire that the bulk of the funds should be expended in providing a badge of office to be used in perpetuity by the Provost of the Burgh. At his request, therefore, the testimonial took the form of a Provost's badge with a suitable inscription. Mr. Shanks himself had purchased a gold chain to go along with the badge. Additional gifts to the ex-Provost were a miniature of the badge, with an inscription containing a record of the testimonial, and a gold cigarette case, and a diamond brooch for Mrs. Shanks.

Wills.

WIGHTMAN, D. C., for many years connected with Messrs. Turton Bros. & Matthews, Limited, steel and railway spring manufacturers, Sheffield ... £91,809

CAMPBELL, G. C., of Darlington, of Messrs. Fergusson, Wild & Company, Limited, Middlesbrough, a director of the Eston Sheet & Galvanising Company, Limited £42,292

Obituary.

MR. W. EADON, proprietor of Messrs. Henry Eadon & Sons, Highbridge Forge, Owlerton, Sheffield, died last week, aged 64.

THE DEATH OCCURRED with great suddenness at his home in Motherwell on June 4 of Mr. Thos. H. Dunlop, of Messrs. Colvilles, Limited, Dalzell Steel Works, Motherwell. Mr. Dunlop was 65 years of age.

Recent Advances in the Field of Silumin Castings.—A patent has been applied for the new heat-treated silumin alloy, named silumin-gamma, which was described in an article bearing the above title in our issue of May 11. The patent application number is 3527, 1932, in the name of Light Alloys, Limited, and W. H. Grieve. In a table published in the same article the fatigue bending strength should, of course, be in kgs. per mm.

Raw Material Markets.

New orders for pig-iron are still somewhat limited, actual consumption maintaining a steady level. Prospects have improved at some of the foundries, especially those engaged in the production of light castings. Finished steel has been a quiet market, but prospects in the semi-finished steel trade have improved, especially so since the establishment of higher prices by the Continental Steel Cartel.

A great deal depends upon the International Economic Conference now being held in London; a favourable outcome would considerably influence market sentiment.

Pig-Iron.

MIDDLESBROUGH.—The market displays a firm tone. Most of the steel furnaces in this area worked as usual over Whitsun, and only one or two of the mills were idle for a day. There was little or no need to add to the stocks of iron. One or two of the local foundries are busier, and are entering into contracts for short periods ahead. Inquiries from Scandinavian and Baltic countries have shown a welcome increase. For the export market, Cleveland ironmasters are quoting very low figures. Home prices, however, are regulated by the fixed-price agreement. Delivered in the Middlesbrough area, No. 3 Cleveland G.M.B. is still quoted at 62s. 6d. per ton, compared with 62s. 9d. delivered Glasgow and 64s. 6d. delivered North-East Coast. For No. 1 foundry iron 2s. 6d. per ton extra is charged, while 1s. per ton less than No. 3 G.M.B. iron is asked in the case of No. 4 foundry and No. 4 forge.

East Coast hematite is still quoted at 59s. for mixed numbers and 59s. 6d. for No. 1 quality, at which prices the makers are still prepared to book forward, though they hardly cover the cost of production. The market is still weighed down, however, by large stocks of unsold material.

LANCASHIRE.—Work in this district has now resumed its normal course, and deliveries have been fully resumed. New orders are still on a rather limited scale. The general price position is unchanged, offers for delivery to users in the Manchester price zone being on the basis of 67s. per ton for Derbyshire, Staffordshire and North-East Coast brands of No. 3, 65s. 6d. for Northamptonshire, 62s. for Derbyshire forge iron, about 80s. for Scottish foundry, and around 75s. 6d. and 80s. 6d. respectively for East and West Coast hematite.

MIDLANDS.—Conditions in this area continue to show improvement. More activity is reported in the light-castings trade, although some of the heavy engineering works are still comparatively slack. Prices have undergone no change, the Midland zone figures being 62s. 6d. for Northants No 3 and 66s. for North Staffordshire and Lincolnshire No. 3. These prices are delivered to Birmingham and Black Country stations, and are subject to a small rebate to large consumers. There continues to be a fair call for special foundry pig-iron. Low-phosphorus irons are from 80s. to 90s. per ton delivered this district, with Scottish at about 85s. per ton. Other medium-phosphorus irons for special trades range from 70s. to 80s. per ton delivered this district. In the hematite market, business is only for small lots for immediate consumption. Only West Coast iron is controlled, the figure being 84s. 6d. per ton delivered here for No. 3 or mixed numbers. Welsh and East Coast prices range from 74s. 6d. to 77s. 6d., according to quality and tonnage.

SCOTLAND.—That activity is at a low ebb at many of the Scottish foundries is indicated by the fact that only 4,000 tons of Middlesbrough iron were imported during May. The pig-iron market has been generally sluggish, but prices are maintained. There is no change to report in prices and the official minimum of 65s. for No. 3 foundry f.o.t. furnaces is still in force, with 2s. 6d. per ton extra for No. 1. With the export trade so bad, there is little outlet for No. 1. No. 3 Middlesbrough is quoted at 59s. 9d. Falkirk district and 62s. 9d. Glasgow area, with other English irons offered at 2s. 3d. per ton below these figures.

Coke.

The coke market remains rather slow, purchases being limited to immediate needs. Best Durham coke is 36s. 6d. to 38s., with other qualities 34s. to 35s. and Welsh coke from 30s. to about 45s., delivered to Midland stations. Scottish coke of a good grade is being sent into South Staffordshire at about 40s. per ton.

Steel.

Fairly active conditions have ruled in the steel markets, and, although there has been some seasonal falling-off in the demand, it has not been so noticeable as in recent years. In the semi-finished steel section of the market, an active demand has ruled, and, in the absence of offerings from Continental sources, consumers are showing more inclination to enter into forward contracts. Nearly all the Continental semi-finished material now entering this country represents balances of contracts arranged some time ago, and these are being rapidly worked off. In the finished-steel department business has been moderately active, and there has been a fair inquiry on export account. The general demand from the heavier consuming industries also shows signs of expansion.

Scrap.

The Cleveland scrap-iron market is rather dull at the moment, many of the bigger foundries being well covered for their current requirements. Ordinary heavy is at 38s. 6d. to 40s. and machinery quality at 41s. Midlands foundries are fairly busy and there is a steady demand for scrap in that area, quotations being 47s. 6d. for heavy machinery quality, 45s. for heavy pipe and plate and 37s. 6d. for clean light, all delivered. In South Wales supplies are plentiful and there is only a weak demand. In the Scottish market first-class machinery cast iron, in pieces not exceeding 1 cwt., remains at 48s. 6d. to 50s., ordinary cast iron to the same specification being at 44s. per ton.

Metals.

Copper.—Although still displaying a firm tone, current quotations are somewhat lower when compared with last week's levels. This is due to a certain extent to the drying-up of buying by European consumers, particularly in Germany and Italy, whence a considerable amount of the recent purchasing has originated. This has caused a momentary setback in the market, but there is little likelihood of a reversion to the low price levels ruling a month or two ago. The situation in the American market is fairly satisfactory, and prices are firm. A considerable amount of domestic buying is reported to have taken place recently, and it is believed that the rate of consumption is at last moving upwards.

In this connection it is interesting to note the annual statistics of world copper consumption for 1932 just issued by the American Bureau of Metal Statistics. These show that world consumption during 1932 amounted to 1,077,278 short tons, the lowest total since 1921, and which compares with 1,404,440 tons in 1931. During 1932 American consumption fell to about 56 per cent. of the 1931 total. It is, therefore, encouraging to note that, comparing 1932 with 1931, consumption of copper in Great Britain showed an increase of approximately 10 per cent.

The week's prices have been as follow :—

Cash.—Thursday, £37 6s. 3d. to £37 7s. 6d.; Friday, £37 5s. to £37 7s. 6d.; Monday, £35 13s. 9d. to £35 15s.; Tuesday, £36 5s. to £36 7s. 6d.; Wednesday, £35 17s. 6d. to £36.

Three Months. — Thursday, £37 10s. to £37 11s. 3d.; Friday, £37 10s. to £37 12s. 6d.; Monday, £35 17s. 6d. to £35 18s. 9d.; Tuesday, £36 8s. 9d. to £36 11s. 3d.; Wednesday, £36 2s. 6d. to £36 5s.

Tin.—Quotations in the tin market have shown an erratic tendency lately, although generally remaining at a high level. Messrs. Brandeis, Goldschmidt & Company state in their weekly report that "the spectacular rise which has taken place during the past months has been maintained and the price has reached a new level of about £225 three months. This is more than £100 higher than the price a year ago, when the market was anything but firm. The total visible supplies, including the carry-over, have in the meantime decreased by over 10,000 tons, but the stocks are still some 4,000 tons higher than they were three years ago, when the price was about £141, and over 20,000 tons higher than at the end of May, 1929, when the price was below £200. These figures do not of themselves prove anything, but they do give an indication of the artificial nature of the market. It is possible that the price will advance further, since apparently no arrangements have been made by the various countries in the restriction scheme for preventing the price from moving to any limit upwards. We can only repeat that such a result would not be in the best interests of the trade and that the market is in a dangerous condition."

Daily quotations :—

Cash.—Thursday, £221 5s. to £221 10s.; Friday, £227 5s. to £227 10s.; Monday, £222 15s. to £222 17s. 6d.; Tuesday, £224 to £224 5s.; Wednesday, £221 15s. to £222.

Three Months.—Thursday, £221 5s. to £221 10s.; Friday, £227 5s. to £227 10s.; Monday, £222 15s. to £222 17s. 6d.; Tuesday, £224 to £224 5s.; Wednesday, £221 15s. to £222.

Spelter.—The demand for this metal is improving, following better conditions in the consuming trades. Reports are to hand of the zinc-sheet demand being at the best level for years, while both brass and zinc rollers are reported to be more actively engaged, the galvanising trade remaining the one weak spot. Quotations established a new high level for the year on Friday, although a slight relapse has since been seen.

Price fluctuations :—

Ordinary.—Thursday, £16 16s. 3d.; Friday, £17; Monday, £16 11s. 3d.; Tuesday, £16 17s. 6d.; Wednesday, £16 13s. 9d.

Lead.—There is a healthy demand for lead from the consuming industries, and prospects in this market are regarded as very favourable. The slight fluctuations in prices which have occurred may be accounted to the exceptional activity which has recently taken place on the London Exchange.

Daily market prices :—

Soft Foreign (Prompt).—Thursday, £13 10s.; Friday, £13 10s.; Monday, £13 6s. 3d.; Tuesday, £13 7s. 6d.; Wednesday, £13 3s. 9d.

CAST IRON FLANGED PIPES
2 in.–12 in. & CONNECTIONS. to 24 in. dia.
WE HAVE FIFTY-TWO YEARS OF ACCUMULATED EXPERIENCE AND METAL PATTERNS.
JAMES & RONALD RITCHIE, LTD.,
Telephone: 3852 (2 Lines). MIDDLESBROUGH. Telegrams: "Ritchie, Middlesbrough."

XUM

FOUNDRY BOXES

...that speed up production for the Modern Foundry—

One of the greatest improvements you can introduce into your foundry is the STERLING ROLLED STEEL MOULDING BOX . . . . the result is speed and economy all round. Your moulders will put down more moulds per day because of the light and easy handling properties of these boxes.

You will be sure of producing accurate castings because STERLING BOXES maintain their accuracy permanently. Also your moulding costs will be halved—STERLING BOXES stand up to heavy service, anywhere.

Sterling

UP-TO-DATE

MOULDING BOX EQUIPMENT

Save their cost in a few months, and are obviously a sound investment for any foundry.

STERLING FOUNDRY SPECIALTIES LTD.,

WORKS— BEDFORD.

LONDON OFFICE:— 13, VICTORIA STREET, S.W.1.

Agents at GLASGOW and MANCHESTER

XUM

WEEKLY PRICE CURRENT.

COPPER.

	£ s. d.
Standard cash	35 17 6
Three months	36 2 6
Electrolytic	40 10 0
Tough	38 10 0
Best selected	39 0 0
Sheets	68 0 0
India	49 10 0
Wire bars	41 5 0
Do., July	41 7 6
Do., August	41 10 0
Ingot bars	41 5 0
H.C. wire rods	43 10 0
Off. av. cash, May	34 2 1 5/16
Do., 3 mths., May	34 6 2 6/23
Do., Sttlmnt., May	34 2 2 5/23
Do., Electro, May	38 11 4 7/23
Do., B.S., May	37 2 6
Do., wire bars, May	38 19 5 1/23
Solid drawn tubes	10½d.
Brazed tubes	10½d.
Wire	7d.

BRASS.

Solid drawn tubes	9½d.
Brazed tubes	11½d.
Rods, drawn	8½d.
Rods, extd. or rlld.	5d.
Sheets to 10 w.g.	8½d.
Wire	7½d.
Rolled metal	7½d.
Yellow metal rods	4½d.
Do. 4 × 4 Squares	5½d.
Do. 4 × 3 Sheets	5½d.

TIN.

	£ s. d.
Standard cash	221 15 0
Three months	221 15 0
English	223 0 0
Bars	224 15 0
Straits	241 0 0
Australian (nom.)	—
Eastern	240 5 0
Banca (nom.)	238 0 0
Off. av. cash, May	186 5 10 2/23
Do., 3 mths., May	186 13 7 3/23
Do., Sttlmt., May	186 6 8 2/23

SPELTER.

	£ s. d.
Ordinary	16 13 9
Remelted	16 7 6
Hard	14 0 0
Electro 99.9	19 0 0
English	17 10 0
India	15 10 0
Zinc dust	19 0 0
Zinc ashes	2 7 6
Off. aver., May	15 11 7 1/16
Aver. spot, May	15 10 1 7/23

LEAD.

	£ s. d.
Soft foreign ppt.	13 3 9
Empire	13 12 6
English	14 10 0
Off. average, May	12 4 8 5/23
Average spot, May	12 1 10 2/23

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	25 0 0
Do., V.M. ex-whse.	24 0 0
Rods	28 0 0
Boiler plates	—
Battery plates	—

ANTIMONY.

	£ s. d.
English	35 0 0 to 40 0 0
Chinese	28 10 0
Crude	—

QUICKSILVER.

	£ s. d.
Quicksilver	8 15 0 to 9 5 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro silicon—	
25%	7 15 0
45/50%	12 2 6
75%	18 17 6
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free of Mo.	6/3 per lb.
Ferro-titanium—	
23/25% carbon-free	10d. lb.
Ferro-phosphorus, 20/25%	£17 17 6
Ferro-tungsten—	
80/85%	1/6 lb.
Tungsten metal powder—	
98/99%	1/9 lb.
Ferro-chrome—	
2/4% car.	25 5 0
4/6% car.	21 15 0
6/8% car.	19 17 6
8/10% car.	19 17 6
Ferro-chrome—	
Max. 2% car.	30 0 0
Max. 1% car.	31 0 0
Max. 0.70% car.	42 10 0
70% carbon-free	11d.
Nickel—99.5/100%	£225 to £230
"F" nickel shot	£202 10 0
Ferro-cobalt	5/9 lb.
Aluminium 98/99%	£100 0 0
Metallic chromium—	
96/98%	2/8 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export (nom.)	£9 15 0
Metallic manganese—	
94/96% carbon-free	1/2 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 3/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£ s. d.	£ s. d.
South Wales—		
Heavy steel	2 3 0	to 2 5 0
Bundled steel and shrngs.	1 17 6	to 2 3 0
Mixed iron and steel		2 0 0
Heavy cast iron		2 2 6
Good machinery		2 8 0
Cleveland—		
Heavy steel		1 17 6
Steel turnings		1 11 6
Cast-iron borings		1 2 0
Heavy forge		2 10 0
W.I. piling scrap		2 0 0
Cast-iron scrap	1 18 6	to 2 1 0
Midlands—		
Light cast-iron scrap		1 17 6
Heavy wrought iron		2 5 0
Steel turnings, f.o.r.	1 4 6	to 1 5 6
Scotland—		
Heavy steel	1 17 6	to 1 18 9
Ordinary cast iron		2 4 0
Engineers' turnings		1 11 9
Cast-iron borings	1 12 6	to 1 13 6
Wrought-iron piling		2 1 3
Heavy machinery	2 8 6	to 2 10 0

London—Merchants' buying prices, delivered yard.

	£ s. d.
Copper (clean)	28 0 0
Brass	19 0 0
Lead (less usual draft)	12 0 0
Tea lead	10 0 0
Zinc	10 0 0
New aluminium cuttings	74 0 0
Braziery copper	24 0 0
Gunmetal	22 0 0
Hollow pewter	140 0 0
Shaped black pewter	100 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	65/-
Foundry No. 3	62/6
,, at Falkirk	59/9
,, at Glasgow	62/9
Foundry No. 4	61/6
Forge No. 4	61/6
Hematite No. 1, f.o.t.	59/6
Hematite M/Nos., f.o.t.	59/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	68/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	62/-
,, No. 3 fdry.	66/-
Northants forge	58/6
,, fdry. No. 3	62/6
,, fdry. No. 1	65/6
Derbyshire forge	62/-
,, fdry. No. 3	66/-
,, fdry. No. 1	69/-
Scotland—	
Foundry No. 1	67/6
,, No. 3	65/-
Hem. M/Nos. d/d	66/-
Sheffield (d/d district)—	
Derby forge	59/6
,, fdry. No. 3	63/6
Lincs forge	59/6
,, fdry. No. 3	63/6
E.C. hematite	73/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	82/-
Clyde, No. 3	82/-
Monkland, No. 3	82/-
Summerlee, No. 3	82/-
Eglinton, No. 3	82/-
Gartsherrie, No. 3	82/-
Shotts, No. 3	82/-

FINISHED IRON AND STEEL.

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.)	9 0 0	to 9 15 0
Nut and bolt iron	6 15 0	to 7 10 0
Hoops	10 10 0	to 12 0 0
Marked bars (Staffs) f.o.t.		12 0 0
Gas strip	10 10 0	to 12 0 0
Bolts and nuts, ¾ in. × 4 in.		12 17 6
Steel—		
Plates, ship, etc.	8 15 0	to 8 17 6
Boiler plts.		8 5 0
Chequer plts.		10 7 6
Angles		8 7 6
Tees		9 7 6
Joists		8 15 0
Rounds and squares, 3 in. to 5½ in.		9 7 6
Rounds under 3 in. to ¾ in. (Untested)	6 15 0	& up.
Flats—8 in. wide and over		8 12 6
,, under 8 in. and over 5 in.		8 17 6
Rails, heavy	8 5 0	to 8 10 0
Fishplates		12 0 0
Hoops (Staffs)	9 10 0	& up.
Black sheets, 24g. (10-t. lots)		9 15 0
Galv. cor. shts. ,,		12 0 0
Galv. flat shts. ,,		12 10 0
Galv. fencing wire, 8g. plain		14 0 0
Billets, soft	5 0 0	to 5 12 6
Billets, hard	6 12 6	to 7 2 6
Sheet bars	4 15 0	to 5 2 6
Tin bars		4 15 0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	11d.
Sheet to 10 w.g.	12d.
Wire	12⅝d.
Rods	11d.
Tubes	15½d.
Castings	13d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	16.34
No. 2 foundry, Valley	15.50
No. 2 foundry, Birm.	12.00
Basic	16.89
Bessemer	17.89
Malleable	17.39
Grey forge	17.39
Ferro-mang. 80%, seaboard	68.00
O.-h. rails, h'y, at mill	40.00
Billets	26.00
Sheet bars	26.00
Wire rods	35.00
	Cents.
Iron bars, Phila.	1.86
Steel bars	1.60
Tank plates	1.60
Beams, etc.	1.60
Skelp, grooved steel	1.60
Steel hoops	1.55
Sheets, black, No. 24	2.10
Sheets, galv., No. 24	2.70
Wire nails	1.85
Plain wire	2.10
Barbed wire, galv.	2.35
Tinplates, 100-lb. box	$4.25

COKE (at ovens).

Welsh foundry	20/- to 22/6
,, furnace	15/- to 16/-
Durham and Northumberland—	
,, foundry	21/- to 25/-
,, furnace	13/3
Midlands, foundry	—
,, furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box		17/- to 17/6
,,	28×20	,,	34/- to 35/-
,,	20×10	,,	24/9
,,	18¾×14	,,	18/-
C.W.	20×14	,,	15/6
,,	28×20	,,	32/6
,,	20×10	,,	—
,,	18¾×14	,,	—

SWEDISH CHARCOAL IRON & STEEL.

	£ s. d.	£ s. d.
Pig-iron	£6 0 0	to £7 0 0
Bars-hammered, basis	£16 10 0	to £17 0 0
Bars and nail-rods, rolled, basis	£15 17 6	to £16 5 0
Blooms	£10 0 0	to £12 0 0
Keg steel	£32 0 0	to £33 0 0
Faggot steel	£18 0 0	to £23 0 0
Bars and rods dead soft, st'l	£10 0 0	to £12 0 0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.	
June	8 ..	37	6	3 dec.	5/-
,,	9 ..	37	5	0 ,,	1/3
,,	12 ..	35	13	9 ,,	31/3
,,	13 ..	36	5	0 inc.	11/3
,,	14 ..	35	17	6 dec.	7/6

Electrolytic Copper.

		£	s.	d.	
June	8 ..	42	5	0 dec.	5/-
,,	9 ..	42	0	0 ,,	5/-
,,	12 ..	40	10	0 ,,	30/-
,,	13 ..	40	10	0 No change	
,,	14 ..	40	10	0 ,, ,,	

Standard Tin (cash).

		£	s.	d.	
June	8 ..	221	5	0 inc.	115/-
,,	9 ..	227	5	0 ,,	120/-
,,	12 ..	222	15	0 dec.	90/-
,,	13 ..	224	0	0 inc.	25/-
,,	14 ..	221	15	0 dec.	45/-

Tin (English ingots).

		£	s.	d.	
June	8 ..	222	15	0 inc.	120/-
,,	9 ..	228	15	0 ,,	120/-
,,	12 ..	224	0	0 dec.	95/-
,,	13 ..	225	5	0 inc.	25/-
,,	14 ..	223	0	0 dec.	45/-

Spelter (ordinary).

		£	s.	d.	
June	8 ..	16	16	3 inc.	5/-
,,	9 ..	17	0	0 ,,	3/9
,,	12 ..	16	11	3 dec.	8/9
,,	13 ..	16	17	6 inc.	6/3
,,	14 ..	16	13	9 dec.	3/9

Spelter (Electro, 99.9 per cent.).

		£	s.	d.	
June	8 ..	18	17	6 No change	
,,	9 ..	19	5	0 inc.	7/6
,,	12 ..	18	17	6 dec.	7/6
,,	13 ..	19	0	0 inc.	2/6
,,	14 ..	19	0	0 No change	

Zinc Sheets (English).

		£	s.	d.	
June	8 ..	25	0	0 No change	
,,	9 ..	25	0	0 ,,	,,
,,	12 ..	25	0	0 ,,	,,
,,	13 ..	25	0	0 ,,	,,
,,	14 ..	25	0	0 ,,	,,

Lead (English).

		£	s.	d.	
June	8 ..	14	15	0 No change	
,,	9 ..	14	15	0 ,,	,,
,,	12 ..	14	15	0 ,,	,,
,,	13 ..	14	15	0 ,,	,,
,,	14 ..	14	10	0 dec.	5/-

AVERAGE MONTHLY PRICES OF DERBYSHIRE NO. 3 FOUNDRY AT MANCHESTER.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1897	2 10 0	2 11 0	2 9 0	2 8 6	2 8 0	2 7 0	2 7 0	2 7 0	2 6 0	2 6 0	2 6 6	2 7 6	2 7 9½
1898	2 7 6	2 8 0	2 8 0	2 8 0	2 8 6	2 10 0	2 10 0	2 10 0	2 10 0	2 11 0	2 14 0	2 14 0	2 9 11
1899	2 13 0	2 14 0	2 14 0	2 14 0	3 0 0	3 2 0	3 13 0	3 16 6	3 15 0	3 16 6	3 16 6	4 0 0	3 6 2½
1900	4 0 0	4 0 0	4 0 0	4 1 6	4 1 0	3 18 0	3 13 6	3 12 6	3 11 0	3 11 0	3 9 6	3 8 0	3 15 5
1901	2 13 6	2 17 0	2 15 0	2 15 0	2 14 0	2 13 9	2 13 6	2 13 6	2 14 6	2 13 0	2 12 6	2 16 6	2 14 3½
1902	2 17 6	2 17 6	2 15 6	2 16 9	2 16 6	2 16 6	2 16 6	2 17 0	2 18 6	2 18 6	2 17 6	2 17 6	2 17 1½
1903	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
1904	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
1905	2 13 0	2 13 0	2 11 6	2 12 6	2 12 0	2 12 0	2 12 3	2 12 3	2 14 0	2 16 6	3 0 0	3 0 6	2 14 1
1906	3 2 0	3 5 0	3 3 0	3 0 6	2 17 0	2 18 6	2 18 0	2 16 6	2 19 0	3 0 6	3 1 6	3 7 0	3 0 8½
1907	3 7 0	3 7 0	3 5 0	3 2 0	3 4 0	3 8 0	3 6 0	3 5 0	3 4 0	3 2 6	3 1 0	2 18 6	3 4 2
1908	2 15 0	2 14 6	2 14 6	2 15 6	2 14 0	2 13 0	2 13 0	2 11 6	2 12 6	2 13 0	2 12	2 12 6	2 13 5½
1909	2 13 0	2 12 6	2 11 6	2 12 0	2 12 6	2 12 6	2 12 0	2 12 6	2 14 6	2 15 0	2 14 6	2 14 0	2 13 0½
1910	2 13 9	2 14 0	2 14 0	2 14 4	2 15 0	2 15 0	2 14 9	2 15 0	2 15 0	2 15 0	2 15 0	2 15 0	2 14 7½
1911	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 14 6	2 15 0	2 15 0	2 15 8½
1912	2 17 4½	2 17 6	2 17 6	3 1 1½	3 2 6	3 3 9	3 6 3	3 7 6	3 10 10½	3 12 6	3 13 3½	3 14 6	3 5 4
1913	3 15 7	3 15 0	3 11 10½	3 11 4½	3 10 2½	3 6 10½	3 4 2½	3 2 9	3 1 9	3 1 0	2 19 3	2 17 2½	3 6 5
1914	2 17 2½	2 18 0	2 18 0	2 17 0	2 17 0	2 16 7½	2 16 0	3 2 10	3 1 0	2 19 9½	2 16 11½	2 18 1½	2 18 2
1915	3 1 2	3 3 11	3 5 9	3 18 8½	3 13 7	3 14 1	3 15 0	3 13 3	3 12 0½	3 11 1	3 14 0	4 3 3	3 12 2½
1916	4 4 6½	4 11 6	4 11 6½	4 7 6	4 7 6	4 7 6	4 10 0	4 12 10	4 12 6	4 12 6	4 12 6	4 12 6	4 8 6½
1917	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6
1918	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6
1919	4 12 6	4 12 6	4 12 6	4 12 6	7 2 6	7 5 0	8 8 5	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	7 3 10
1920	9 13 9	10 0 0	10 5 3	10 15 3	11 10 0	12 2 6	12 5 0	13 1 3	14 7 6	14 5 0	14 5 0	14 5 0	12 12 1½
1921	12 11 8	10 8 9	9 2 6	8 2 0	8 0 0	8 0 0	8 0 0	8 1 8	7 4 0	6 7 6	5 7 6	4 16 10	8 0 2
1922	5 5 0	4 17 6	4 15 0	4 15 0	4 12 6	4 12 6	4 12 6	4 12 6	4 11 3	4 10 0	4 10 0	4 10 0	4 13 7½
1923	4 12 8½	5 0 2	6 2 6	6 8 7½	6 2 5	5 11 9	5 9 1½	5 4 0	5 0 0	5 0 9	5 0 7	5 2 9	5 7 11½
1924	5 3 0	5 3 0	5 3 0	5 3 0	5 2 10	5 1 3	4 17 11	4 15 6	4 13 6	4 10 1½	4 10 0	4 10 3	4 17 9½
1925	4 10 0	4 9 0	4 6 9	4 5 2½	4 3 0	4 0 1½	4 17 1½	3 15 7½	3 14 3½	3 13 4½	3 13 4½	3 13 2½	4 1 9
1926	3 14 9	3 15 3	3 15 6	3 15 3½	3 17 6	4 5 9	4 16 9	*	*	*	*	4 12 6	4 0 1½
1927	4 13 9½	4 13 3	4 11 1½	4 9 4½	4 6 1½	3 19 1½	3 16 1½	3 15 6	3 13 4½	3 13 4½	3 14 0	3 13 6½	4 1 6½
1928	3 13 2½	3 12 3½	3 12 3	3 12 3	3 11 6	3 10 0	3 8 3	3 7 8½	3 7 6	3 7 9½	3 8 3	3 7 6	3 9 10½
1929	3 8 3½	3 10 4½	3 10 10½	3 11 0	3 11 2½	3 12 0	3 12 4½	3 14 6	3 15 1½	3 17 0	3 17 0	3 17 0	3 13 1½
1930	3 17 0	3 17 0	3 17 0	3 17 0	3 17 0	3 17 0	3 15 0	3 12 0	3 12 0	3 12 0	3 10 1½	3 9 6	3 14 4½
1931	3 9 6	3 9 6	3 9 6	3 9 6	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 10
1932	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0
1933	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	—	—	—	—	—	—	—	—

* No prices available during strike period.

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.

13, RUMFORD STREET, LIVERPOOL.

PIG IRON

REGISTERED TRADE MARKS

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.

ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

ADVERTISER, with 14 years' experience in iron-foundry management, desires a similar position where a sound practical and technical training can be made use of. Straight and special pipes, general engineering and non-ferrous castings.—Box 414, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Representative, resident East Midlands, with sound connection, requires good line for the foundry.—Box 416, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

ADVERTISER, who is presently engaged as Foundry Manager with one of the largest bath-making firms in the country, is open to consider similar or executive position with a firm of repute. Has a sound practical experience in the manufacture of baths, either machine, block or shell patterns, producing castings that ensures successful results in the enamelling process. Has a thorough experience also in general light-casting production.—Box 436, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED, Charge Hand with thorough knowledge of production of baths in all branches; first-class reference only. State experience, age, and salary required (London foundry).—Box 440, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

POSITION required as Foreman, Assistant Foreman or Assistant to Foundry Manager by young Moulder with sound practical experience. Secondary school education, good technical qualifications, age 30. Willing to go abroad. (214)

PROGRESSIVE position required by young man who has completed full-time course in foundry practice and has had melting and metallurgical experience with well-known foundry. (215)

PARTNERSHIP.

PARTNER wanted for Grey-iron Foundry; must be good all-round, practical man; small investment in guaranteed business.—Apply, Box 442, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PUBLICATION

RYLAND'S DIRECTORY of the Coal, Iron, Steel, Tinplate, Metal, Engineering, Hardware and Allied Trades. A new edition will be going to press soon. *Write now* for full particulars and advertisement rates.—INDUSTRIAL NEWSPAPERS, LIMITED, 49, Wellington Street, Strand, London, W.C.2.

PATENT.

THE Proprietor of British Patent No. 308517, dated May 30, 1928, relating to "Improvement in a Hot Top for Ingot Moulds," is desirous of entering into arrangements by way of a Licence or otherwise on reasonable terms for the purpose of exploiting the above Patent and ensuring its practical working in Great Britain.—Inquiries to B. Singer, Steger Building, Chicago, Illinois.

PROPERTY.

MAGNIFICENT

11 ACRES WORKS SITE.

SHEFFIELD.

145,000 Sq. Ft. of Shops.

SIDING CONNECTIONS

with L.M. & S. and L. & N.E. Rlys.

WELL-BUILT & COMMODIOUS OFFICES

Will Sell whole or in lots to suit customers or Let on favourable terms. Unique opportunity for Manufacturers.

Apply—

THOS. W. WARD, LTD.,

ALBION WORKS, SHEFFIELD.

MACHINERY.

WANTED immediately, a 6-ft. 0-in. dia. Wet Loam Pan Mixer.—Price and full particulars to JAMES & RONALD RITCHIE, LIMITED, Acklam Foundry, Middlesbrough.

WANTED.—Steel Foundry requires full Laboratory Outfit; recording pyrometer, microphotographic apparatus with specimen-polisher, modern chemical balances and Brinell hardness-testing machine; also complete outfit for machine-moulding, air compressor, jolters, squeezers and sand-thrower.—Box 438, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PNEUMATIC MOULDING MACHINES

No. 9 "Ajax" Jolt Turnover.
"Wallwork" Squeezer, 17½-in. x 12½-in. boxes.
"Tabor" Portable Jolt Rollover.
Four No. 1 Britannia Jolters.

HAND MOULDING MACHINES

Eight Standard-size Adaptables with Tail Guides.
Two Large-size Ditto, with Star handle, turnover and adaptable draw frame.
"Coventry" Headpress Squeezer Table, 22 in. x 30 in.
Four 36-in. Farwell Type Universal Squeezers.

Also

Pneulec Sand-drying Plant, 1 ton per hour, Sand Mills, Disintegrators, etc.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.

CROSSWELLS ROAD (Adjoining Railway Crossing), LANGLEY, Nr. Birmingham.

'Phone: Broadwell 1359.

THOS. W. WARD, LTD.

OIL ENGINE, 300 b.h.p., Semi-Diesel, Crude (Vickers Petters).
PUMPING SET, Port. 12", Petrol drive, by W. H. Allen.
SINKING PUMP, "Evans" Vert. "Cornish" D.A., 20,400 galls. per hr. at 100' per min.
VERT. COCHRAN BOILER, 16' 3" x 7' 6" dia., 100 lbs. w.p.
WIRE ROPES, 13/32" dia., 360' long.

Write for "Albion" Catalogue.

'Grams: "Forward." 'Phone: 23001 (10 lines).

ALBION WORKS, SHEFFIELD.

MACHINERY—*Continued.*

FOUNDRY Transverse Bar-Testing Machine by Avery, for 2-in. x 1-in. Bars, 1 to 3 ft. long, calibrated up to 40 cwts., with deflection scale; in good working order. Price £30 or nearest offer.—HARTLEY, SONS & COMPANY, Engineers, Etruria.

SAND-BLASTING PLANTS; 20 complete plants in stock; supplied with or without air compressors; every plant rebuilt ready for use.—A. HAMMOND, 14, Australia Road, Slough.

MISCELLANEOUS.

TO ANY FOUNDRY.—A Pair of Neild Safety First Boots (Prov. Patent No. 8580) will be sent on APPRO. Specially designed to protect from Molten Metal, Sand, etc., and are approved by H.M. Factory Inspectors.—NEILD, Hough End, Bramley, Leeds.

'Phone: 287 SLOUGH

HAND MOULDING MACHINES

Six Standard "Adaptables"	£12 each
Two "LARGE" Adaptables (take 30"×30")	£15 each
24"×30" Darling & Sellars turnover	£15
Two 18"×16" Coventry HEADRAM squeezers	£18 each

PNEUMATIC MACHINES

24"×18" Tabor rollover	£55
30"×20" Macdonald jolt rollover...	£60
20"×16" Macdonald jolt rollover...	£40
No. 20 Macdonald plain jolter with 90"×90" table, jolts 8 tons	£160

AIR COMPRESSORS
ALL SIZES IN STOCK.

Every Machine overhauled and retested.

BUY FROM ME AND SAVE MONEY!

ALEX. HAMMOND, *Foundry Machinery Merchant,*
14, AUSTRALIA ROAD, SLOUGH

COLBOND

is colloidal clay of British origin.
Gives castings a "Satin" finish at a cheaper cost.
Is clean, simple and economical in use.
Gives uniformity of bond throughout.
For all types of castings including Grey Iron, malleable, steel and non-ferrous.

The NEW FOUNDRY PRACTICE
COLBOND.

Particulars from:
COLBOND,
24, Martin Lane, Cannon St., London, E.C.4.
Telephone: Sloane 4862.

RYLAND'S DIRECTORY

[2,200 pages 8½" × 5½"].

The standard work of reference covering the Coal, Iron, Steel, Tinplate, Metal, Engineering, Hardware and Allied Trades.

A new edition will be sent to press soon. Write us now for full particulars and Advertisement rates.

INDUSTRIAL NEWSPAPERS, Ltd.
49, Wellington St., Strand, London, W.C.2.
Telephone: Temple Bar 3951 (5 lines).